Roads in Gazelle Peninsula development

Impact of roads in the post-eruption economic landscape of East New Britain

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April 2010

Published by the Australian Agency for International Development (AusAID), Canberra, April 2010.

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Acknowledgements
The author wishes to acknowledge the assistance of many people, businesses and government agencies in Papua New Guinea and particularly in East New Britain who have contributed to this study.

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National Library of Australia Cataloguing-in-Publication entry

Author: Scales, Ian A., 1963-

Title: Roads in Gazelle Peninsula development : impact of roads in the post-eruption economic landscape of East New Britain

ISBN: 9789980948502

Notes: Bibliography.

Subjects: 1. Roads--Papua New Guinea--Gazelle Peninsula. 2. Agricultural development--Papua New Guinea--Gazelle Peninsula. 3. Economic development--Papua New Guinea--Gazelle Peninsula. 4. Volcanic eruptions--Economic aspects--Papua New Guinea--Gazelle Peninsula. 5. Gazelle Peninsula (Papua New Guinea)--Economic conditions.

Other Authors/Contributors: Australian Agency for International Development.

Dewey Number: 388.1099585

Printed by Birdwing Printing, Port Moresby
Design and layout by Archipel Design, Canberra

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Summary

The Gazelle Peninsula in East New Britain (ENB) is one of Papua New Guinea's most dynamic and important socio-economic landscapes. It was the site of the Rabaul volcanic eruption disaster in 1994, and the subsequent Gazelle Restoration Program.

The major theme of this study is a forward-looking overview of roads in the social and economic development of post-eruption Gazelle Peninsula. This is intended to be of interest to East New Britain Province, the Papua New Guinea policy and planning community, and to development practitioners more generally. The study also assesses the contribution of AusAID-funded road projects, within the overall theme of the study. Using spatial analysis, three topics are covered:

- How roads are used in the northeast Gazelle Peninsula market chain
- Effectiveness of roads in restoration after the 1994 Rabaul volcanic eruption
- Market chains in East New Britain provincial development planning.

The report findings, followed by its main recommendations, are summarised here. Full conclusions and recommendations are found at the end of the report.

Roads in the northeast Gazelle Peninsula market chain

The road network of the northeast Gazelle Peninsula is situated in a highly productive agricultural environment that supports a large and growing rural population. This is an area covering about 10% of the province. The other 90% or so of the province, namely the Pomio and Baining regions, are strongly disadvantaged and are depopulating as people seek better opportunities elsewhere.

The northeast Gazelle road network has developed over a century of crop production into a tightly bound cluster of feeder roads, with a short trunk road to the close-by port of Rabaul. The very short trunk road length allowed a greater proportion of road funds to be used for building the dense feeder road system. As more feeder roads were built, more agricultural potential was tapped, which in turn generated revenue for more roads. This feedback cycle slowed down as the network reached the edges of the best land, transport costs rose with distance, and the burden of maintaining the existing network rose.

Even with the substantial funding for roads as part of the Gazelle Restoration Program, road condition has deteriorated over the last twenty years. Almost half the roads are now in either marginal or poor condition, whereas in 1990, the figure was just under 10%. The province is unable to sustainably maintain all its roads. The available maintenance budget needs to be deployed more effectively, by prioritising the most productive roads within the network. This can be done by a network analysis of the agricultural, transport and maintenance costs and benefits across the provincial roads inventory.

The study looked at use of the road network in various northeast Gazelle market chains. Almost all roads in the network are used for cocoa transport because crop value is relatively high, and freight cost is relatively low, so that worthwhile profit is the outcome. Conversely, in the case of local fresh produce marketing in town, only roads at the centre of the network are used. This is because transport costs toward the outer edges of the network are high in relation to the income received at the market. The lesson here is that unless producers can still earn a profit after they pay for crop transport, they will not use the roads. Transport costs are the key factor. It is not the provision of roads that creates development, but their potential for profitable use.

Roads in the effectiveness of the Gazelle Restoration Program

The Gazelle Restoration Program strategy has had three basic objectives: a) relocation of urban infrastructure, services and population, b) relocation of rural populations, and c) restoration of social and economic linkages. The program goals were not concerned with economic growth, but rather were for relocation away from the Rabaul hazard zone and restoration of the socio-economic *status quo* to at least pre-eruption levels.

AusAID's main project was reconstruction of the national Kokopo-Rabaul trunk road, which was central to the success of the restoration program. The project augmented the road's original market chain role by providing efficient high-volume low-cost freight linkage between the old port and the new township, to help induce businesses to relocate.

Due to the initial effectiveness of the Kokopo-Rabaul road in providing this linkage, in conjunction with success of the urban relocation objectives of the program, urban relocation was effective. Kokopo is now a large urban centre. Infrastructure, services, urban businesses and some export processing was successfully relocated, taking with it most of Rabaul's urban population. Expenditure on the restoration program has driven a 15-year construction boom that, as it ramps down, risks an employment downturn. Even so, the town should remain sustainable when the program ends.

Effectiveness of the road has been reduced, although not yet critically, by extensive mudflow siltation along its length. In addition, the 3.6km long Vulcan section was not in AusAID's original scope and has never been sealed. Unless maintained, the linkage will become inefficient and costly for businesses reliant on it. Dysfunctional linkage to Kokopo may help stimulate redevelopment of Rabaul, which is not desirable.

The port facility at Rabaul could not be relocated. Some major businesses could not move because of essential ties to the port, and these have attracted smaller businesses and some population back into the volcanic hazard zone. On the other hand volcanic ash creates high maintenance costs for the remaining major businesses. Without a viable alternative port site nearby, these major businesses may leave. This will hurt the economic strength of the province.

Rural resettlement was not fully effective. No disaster preparation was in place, so key decisions on rural resettlement were made hastily after the disaster. Formal rural resettlement failed to either replicate the characteristics of the evacuated settlements, or provide a workable alternative. Many people made these arrangements for themselves, so that the bulk of resettlement has ultimately been unofficial, unplanned and unfacilitated. The formal resettlement areas, their purpose-built roads and other new infrastructure are carrying a much lower population than planned.

The focus on post-eruption restoration in the northeast Gazelle Peninsula has left the rest of the province neglected for over a decade, with poverty in those areas now severe.

Market chains in ENB provincial development planning

The ENB provincial administration is planning a roads-based approach to wider development. The approach calls for long-distance roads to the remote areas of the province. They want these roads for two reasons. Firstly, the roads would act as trunk routes to bring produce in from the Pomio and Baining regions, stimulating development there. Secondly the roads would act as growth corridors to induce people to move out of northeast Gazelle, relieving population pressure.

Remote area market chains

In the remote Baining and Pomio areas of the province, feeder roads are very few, but those that do exist lead to coastal shipping points. Trunk freighting in those areas is by small coastal vessels, which pick up produce from the small wharves and deliver it to Rabaul port. This market chain is badly neglected. Its deterioration has led to an almost complete cessation of production from these economically fragile regions of the province.

The long trunk roads proposed for Pomio and Baining development are not the right solution. The maintenance costs of these roads will dwarf current maintenance budgets. Maintenance would be completely unsustainable. Modelling shows agricultural potential of the Pomio and Baining areas to be low. Given the low agricultural output that can be expected, the proposed roads would also have an extremely poor cost-benefit ratio. In addition, very high costs for long-distance road freighting of produce would negate profit to crop producers. A better solution is to develop the sea-linked market chain that already exists around the East New Britain coast. Cost of sea freighting crops from Pomio to Rabaul are comparable to the costs of freighting crops within the

northeast Gazelle area to Rabaul, and this would allow producers to make a profit.

Cost to government to develop a sea-linked market chain is low for initial construction and for maintenance. Unlike trunk roads, sea lanes need no maintenance. This leaves only the cost of wharves and feeder roads. An optimal number of wharves needs to be chosen for commercial development, with each creating its own transport hinterland. Initially, the feeder network should be made of relatively short, low-cost dry-weather roads radiating from each commercial wharf into nearby cropping areas, with foot tracks to more remote populations beyond. The network can be improved and extended as agriculture is developed. This is much the same as the way the northeast Gazelle network was developed a century ago. A further advantage of this pattern of development is that by using a combination of low-cost public investment in feeder roads and wharves, and private investment in buying and stevedoring facilities and in shipping, it spreads costs and employment, and stimulates multipliers in the local economy.

Managing demographic trends in northeast Gazelle

The province hopes to relieve population pressure in northeast Gazelle by out-migration. In fact there is accelerating intensification in the northeast, rather than any decentralisation. This is driven by people seeking better opportunities in areas where per-capita incomes are high. Growth rates more than triple the provincial average are found around Kokopo, and in the new informal agricultural settlement belt nearby where cocoa grows well. Only large scale agricultural development outside the northeast, of which there is no sign at present, would reverse the trend. Planning now needs instead to pay more attention to the realities of managing, and benefiting from, northeast Gazelle intensification rather than hoping to turn the tide. If this is neglected, social disadvantage could easily set in, leading to crime problems for the province.

Spread of Cocoa Pod Borer leading to plummeting export income is a major threat to the province. Pest management and crop diversification strategies are being developed in response. Market chain planning must be coupled to this latest agricultural planning. The provincial growth centre strategy and district development plans need to be reviewed in light of the study's findings about the province's road economics, agricultural potential, and demographic and economic trends.

Summary of recommendations

Refer to the conclusions for full detail.

1. Optimise the northeast Gazelle market chain road network

Prioritise the most productive roads, using network analysis of agricultural, transport and maintenance costs and benefits across the provincial roads inventory. Plan around agricultural diversification in response to Cocoa Pod Borer and climate change. Adopt sustainability and cost-effectiveness as requirements. National road prioritisation to also consider using these methods.

2. Develop sea-link market chain access for remote disadvantaged areas of ENB

Optimise the number of wharves for commercial development. Build low-cost feeder roads to the wharves. Make wharves locally repairable. Extend agricultural technical support to producers. Involve private investment. Adopt sustainability and cost-effectiveness requirements.

3. Improve the condition of the Kokopo-Rabaul Road

Maintenance of siltation, and reconstruction of the Vulcan section must be addressed soon. Road reconstruction should be considered for 2020. New engineering design to address silt build-up.

4. Improve planning for emerging challenges in northeast Gazelle

Current provincial development plans need to be reviewed in the light of findings in this study. Northeast Gazelle intensification must be planned for. Planning for urban business diversification should begin. Planning should begin with data in this report.

Figure 1. Map of the study area, north-east Gazelle Peninsula, East New Britain. The road network is connected with the international port at Rabaul, which is situated at the head of Blanche Bay, a sunken caldera. Nearby are the Vulcan and Tavurvur peaks that erupted in 1994. The road network, and the population, is most dense north of the Kerevat and Warangoi rivers. South of these rivers, the land rises up into the Baining mountains, which are mostly unoccupied, although population is rising in the foothill areas due to land pressure.

1. Introduction

The northeast of the Gazelle Peninsula in East New Britain (ENB) is renowned in Papua New Guinea (PNG) for three unique attributes. First, its economy has historically been dominated by a strong cocoa export economy that has delivered prosperity. Second, it has a dense road network unequalled elsewhere in rural PNG. Third, it was the site of the Rabaul volcanic eruption disaster in 1994, and the subsequent multilateral Gazelle Restoration Program.

This study on the impact of roads for development in the Gazelle Peninsula was conducted by AusAID with the support of the Government of Papua New Guinea and the East New Britain Provincial Administration. It has two themes. The major theme is a forward-looking overview of roads in the social and economic development of post-eruption Gazelle Peninsula. This is intended to be of interest to East New Britain province, the Papua New Guinea policy and planning community, and to development practitioners more generally.

A more specific theme in the study is an assessment of the contribution to social and economic development of AusAID road projects in the Gazelle Peninsula, as AusAID maintains a strong interest in the effectiveness of its development activities. This assessment is threaded through the main overview topics.

The study as a whole covers three inter-related topics, each with its own analysis and lessons learned. The topics are:

- Roads and the Gazelle Peninsula market chain
- Roads and the Rabaul volcanic eruption
- Roads and East New Britain provincial development planning

The study area is mapped in Figure 1. There has been no previous dedicated socio-economic study on roads in the Gazelle Peninsula, although in assisting the Papua New Guinea Government with its transport infrastructure programs, AusAID has produced two national studies on roads, Gannon et. al. (2006) and Allen and Lowe (2006). In terms of road transport studies across PNG overall, this study is unique in using a strongly spatial evidence-based approach to analysis. Scales et. al. (2008) provides a precedent for the approach. Background to the Gazelle Peninsula may be found in other recent publications, mainly on land and agriculture, including Curry et. al. (2007), Martin (2007), and Filer and Lowe (forthcoming), and in a number of anthropologies written in the late 1960s: Epstein (1968), Epstein (1969) and Salisbury (1970).

1.1 Methodology

This study was fieldwork based, with East New Britain fieldwork conducted in two stages: 10 days scoping in September 2008 with a 7-person team, and 52 days main fieldwork from February to April 2009 with a 2-person team. The visits were led by an independent consultant, who also performed the analysis and reporting (Appendix 1). The approach used here is spatial analysis, using datasets that shed light on the socio-economic landscape of Gazelle Peninsula. In addition, ethnographic data was pursued to interpret the results of the mapping. A large number of people in PNG, and particularly within ENB, assisted by providing information and insights for the study (Appendix 2).

For the most part, the study does not use baseline data for a typical ‘before and after’ assessment of development activity. The main reason for this is that attribution could not reasonably be established between particular development projects and overall changes in the socio-economic landscape. Gazelle Peninsula is a dynamic landscape with many powerful drivers of change operating at once. The AusAID projects assessed as part of this study, although by all indications beneficial, were comparatively minor elements in this much larger theatre.

The study assesses four AusAID activities, three of them in part only. The impact assessment cannot avoid inferring the road work activity of other agencies during the restoration period, or the overall impact of the post-eruption restoration programs into which road works fitted.

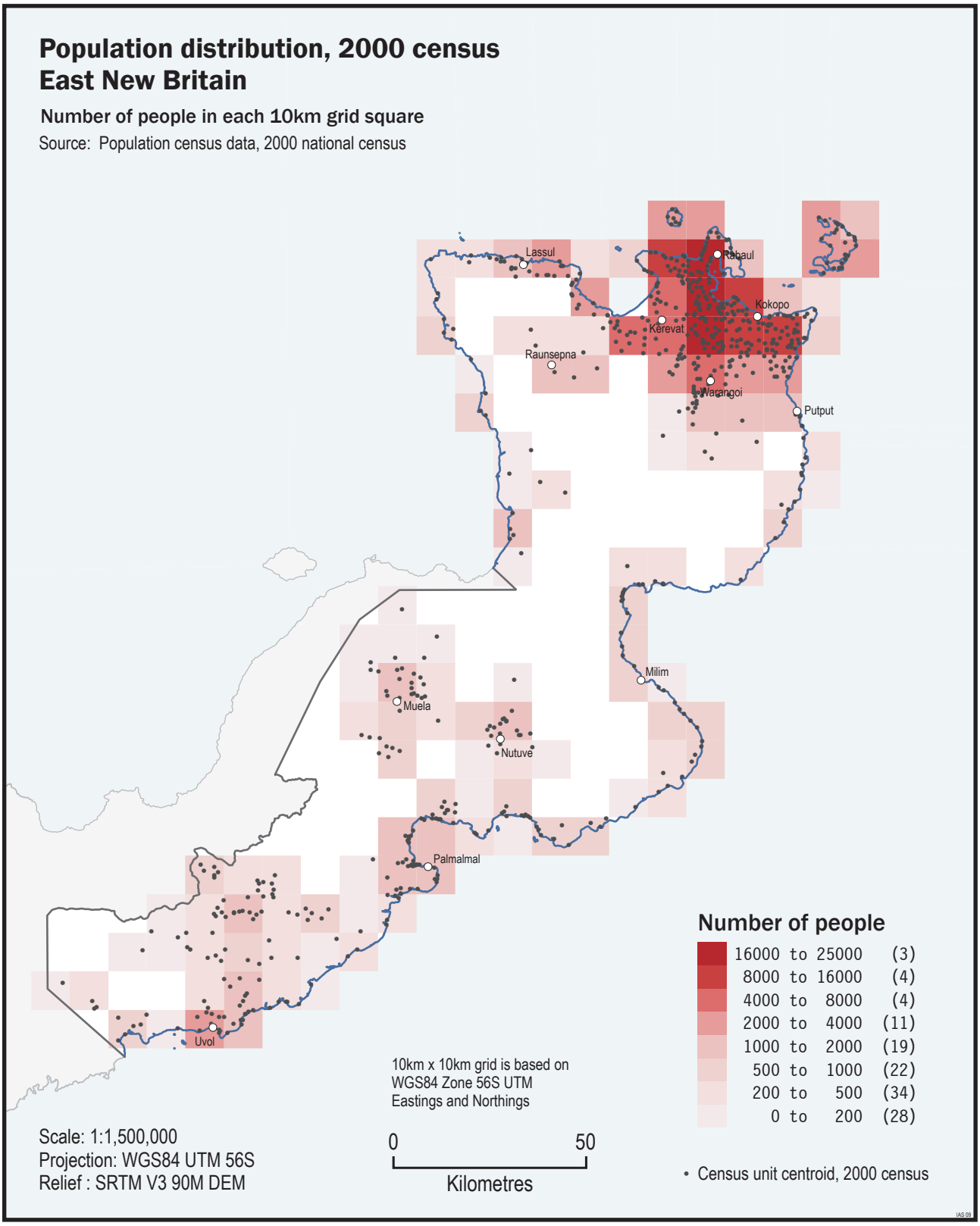


Figure 2. Population distribution in East New Britain at the time of 2000 census. The very strong concentration of population in the northeast Gazelle area is clearly seen, in contrast to much lower population elsewhere. The coast is lightly populated by a string of villages. Inland population clusters are seen in the Baining area, one south of Warangoi and the other around Raunsepna. In Pomio, distinct inland population clusters are seen in i) the Melkoi - Upper Torlu region inland north of Uvol, ii) the Muela area in the upper Pandi catchment (feeding to West New Britain), and iii) the Nutuve area.

Instead of attempting to establish project-level cause and effect, the direction of this study is to understand development policy for roads within the larger theatre. Picking up on the inherently spatial nature of road networks, the main aim of the study was to understand roads in the economy at a more processual level.

For its analysis, the assessment uses socio-economic spatial data in conjunction with ethnographic techniques. The first measures spatial distribution of transport infrastructure in relation to its impacts on market chains and service-delivery chains. The second uses this spatial analysis to elicit stakeholder's own explanations for the distribution of program outcomes.

In PNG, data for a study such as this is not found ready-made. Raw data was found in many places, from license receipt books to company computer records. To construct the maps, all records within each dataset had to be geolocated, that is, places such as addresses or census units had to be located by longitude and latitude coordinates. Quite a few locations share the same or closely similar name. In some cases this had led to confusion in the official data. Many locations were missing from the PNG official GIS. Older maps and local knowledge were used to fill gaps and correct errors. A new dataset for census population mapping was made to fix these errors, add missing locations and add population data. Geolocation of all the study's new data took much longer than expected. Data-matching of locations to coordinates had to be done manually to reach acceptable quality. Google Earth was extensively used for cross-checking locations and also tracing other features like roads, coastlines and agricultural areas.

Many of the maps of the Gazelle area use a 5km² grid to analyse and present the various datasets. This 5km grid was judged to be the appropriate spatial resolution given the map scale, accuracy limitations and the sometimes low spatial density of the data. Maps showing the whole province use a 10 km² grid. This raster mapping is based on the *de facto* standard WGS84 UTM grid and in future could be used with other data in multi-layer spatial economic modelling.

As far as possible, the study used existing provincial data or else used low-cost techniques for extra data collection. Research design also considered possible later use of parts of the study as templates for future socio-economic spatial studies in PNG. Some of the new datasets constructed by the study are attached in the report appendices.

1.2 Gazelle Peninsula context

The Gazelle Peninsula is the north-eastern end of New Britain Island. As the word 'peninsula' indicates, it is a geographically distinct area, set apart from the main bulk of New Britain island by the narrow neck of land between Open Bay and Wide Bay (Figure 1). The Gazelle, together with the Pomio area to its south, and some offshore islands, make up the province of East New Britain. Most of the road network, and the main population, are concentrated in the north-east of the Gazelle Peninsula where land is flat, the soils fertile and the climate mild. This is the location of Rabaul and the new provincial capital, Kokopo. The northeast Gazelle, an area covering 10% of the mainland, is the area that this study is concerned with.

Most land in the northeast Gazelle is traditionally owned by the Oceanic-speaking Tolai people. Land in the rest of the Peninsula is traditionally owned by the Baining people. 'Baining' is a collective name for six related Non-Oceanic language groups, unintelligible to most Oceanic language speakers. Beyond, in Pomio, the people are again mostly Oceanic speakers, in a patchwork of language groups.

The northeast Gazelle has historically been the most developed rural area in Papua New Guinea, while the rest of East New Britain Province is very poor and remote. While the northeast has ideal soils and climate for agriculture, the hinterland is much less fertile. In the northeast, a strong investment in a plantation economy established under German colonial rule was later expanded under Australian rule. The traditional people of the northeast Gazelle, the Tolai, adapted positively to the introduced cash economy.

By geological coincidence, deep and sheltered Rabaul Harbour, which is in fact a sunken caldera surrounded by simmering volcanic peaks, is adjacent to the deep rich volcanic soils erupted from

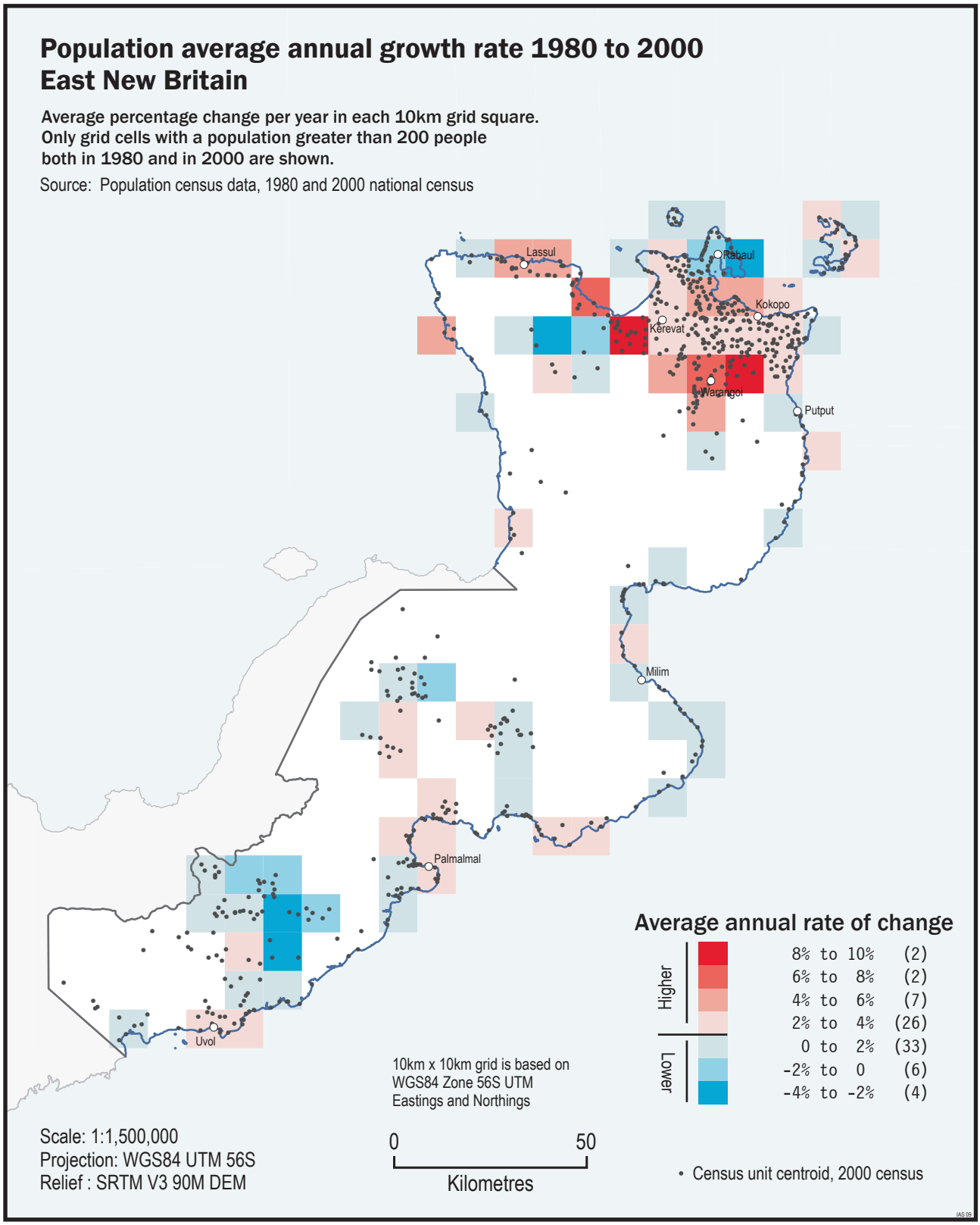


Figure 3. Rates of average annual population growth across East New Britain. Colour-coding in this map reveals 'hot spots' of strong population growth and 'cold spots' where population growth is declining. Average annual growth rate from 1980 to 2000 was 2.2% in ENB, so growth values below this are shown in blue, and those equal or above are shown in red. Areas south of the Kerevat and Warangoi rivers are growing most strongly (although the full effect of Kokopo town growth was not yet reflected in the 2000 census). Rabaul's growth fell due to relocation away from the eruption area. Population growth is weak or in decline in the disadvantaged Baining and Pomio rural areas.

these same volcanoes. The combination of the ideal harbour and ideal soils within this one small area formed the basis for the most dynamic and intense agricultural economy within Papua New Guinea, and made Rabaul a regional hub for primary commodities export.

The road network in the northeast Gazelle, the focus of this study, is a legacy from plantation days. The density of the network grew as produce was carted from every new coconut and cocoa grove established. The plantation era quickly waned upon national Independence in 1975, and much of the plantation land has since reverted to traditionally-based tenure. The role of the road network has diversified in turn, from predominantly market access, to encompass increasing services access, as settlements have sprung up everywhere over old plantation land.

Northeast Gazelle is experiencing a number of unique stresses. The volcanic eruption in 1994 destroyed much of Rabaul town and degraded the port facilities. Official policy is to abandon the area; first as a residential zone and eventually as a port. Since 2006, Cocoa Pod Borer is destroying what has in recent decades become the main export crop, cocoa. The economy is threatened both by the collapse of export crop tonnage and by the degradation of Rabaul port, without outstanding alternatives to deal with either. Northeast Gazelle now has strong population pressure, and social issues are set to intensify as agricultural and port-economy declines make an impact. In essence, the very things that made the northeast Gazelle region so great, are in decline.

1.2.1 Population

Gazelle Peninsula exhibits a strong contrast between the highly concentrated population of northeast Gazelle where 80% of mainland people live, and the low population of the other 90% of the provincial mainland. This is shown in Figure 2.

Figure 2 and Figure 3 are new maps created for the present study from newly geolocated 1980 and 2000 census data. Figure 2 shows the population distribution at the last census in 2000. To map population distribution, both maps are based on a 10km x 10km grid. In Figure 2, all year-2000 census unit populations within each grid cell were tallied. The grid map was then shaded depending on number of people counted in each cell.

Figure 3 shows the average annual rate of population change in each 10km square area between 1980 and 2000.[1] Analysis was limited to just those grid cells where population was greater than 200 people in both 1980 and 2000. Below that number, percentages become too unreliable to use. Over the period 1980-2000, the average annual growth rate in ENB was 2.2%. In view of this, Figure 3 uses blue to represent growth rates below 2% per annum (i.e. rates that are below normal), while red is used for higher rates. Appendix 3 and Appendix 4 contain the geolocated census data used for the mapping. Appendix 5 contains the local level government area name abbreviations used in the geolocated datasets.

Three broad demographic trends show up in Figure 3: i) relocation from Rabaul, ii) northeast Gazelle population growth and iii) stagnant growth and depopulation in remote areas. The strong depopulation (negative growth rate) in Rabaul and nearby villages is due to partial abandonment of these places after the 1994 eruption, and relocation of these people elsewhere.

Moderately high to extreme population growth has occurred around the southern fringe of the northeast Gazelle population area. This correlates with formal resettlement from the Rabaul area, particularly around Warangoi, and also informal settlement along the southern fringe. Informal settlement in the region extending west of Kerevat toward Lassul is notable because no formal resettlement occurred in this region. Moderately high growth occurred in the peri-urban area west of Kokopo. At the time of the 2000 census, redevelopment of Kokopo town was incomplete; this probably explains why stronger growth is not seen around Kokopo.

The third feature of note is the very low rates of population growth, in some cases depopulation, in the remote areas of the province. This correlates strongly with the quite severe poverty in the Pomio and Baining areas (refer to Hanson *et. al*. 2001*a* '*Papua New Guinea Development Handbook*', maps on pp. 260, 261 and 267). The depopulation may be associated with northeast Gazelle in-migration as people leave Pomio and Baining areas in search of better opportunities.

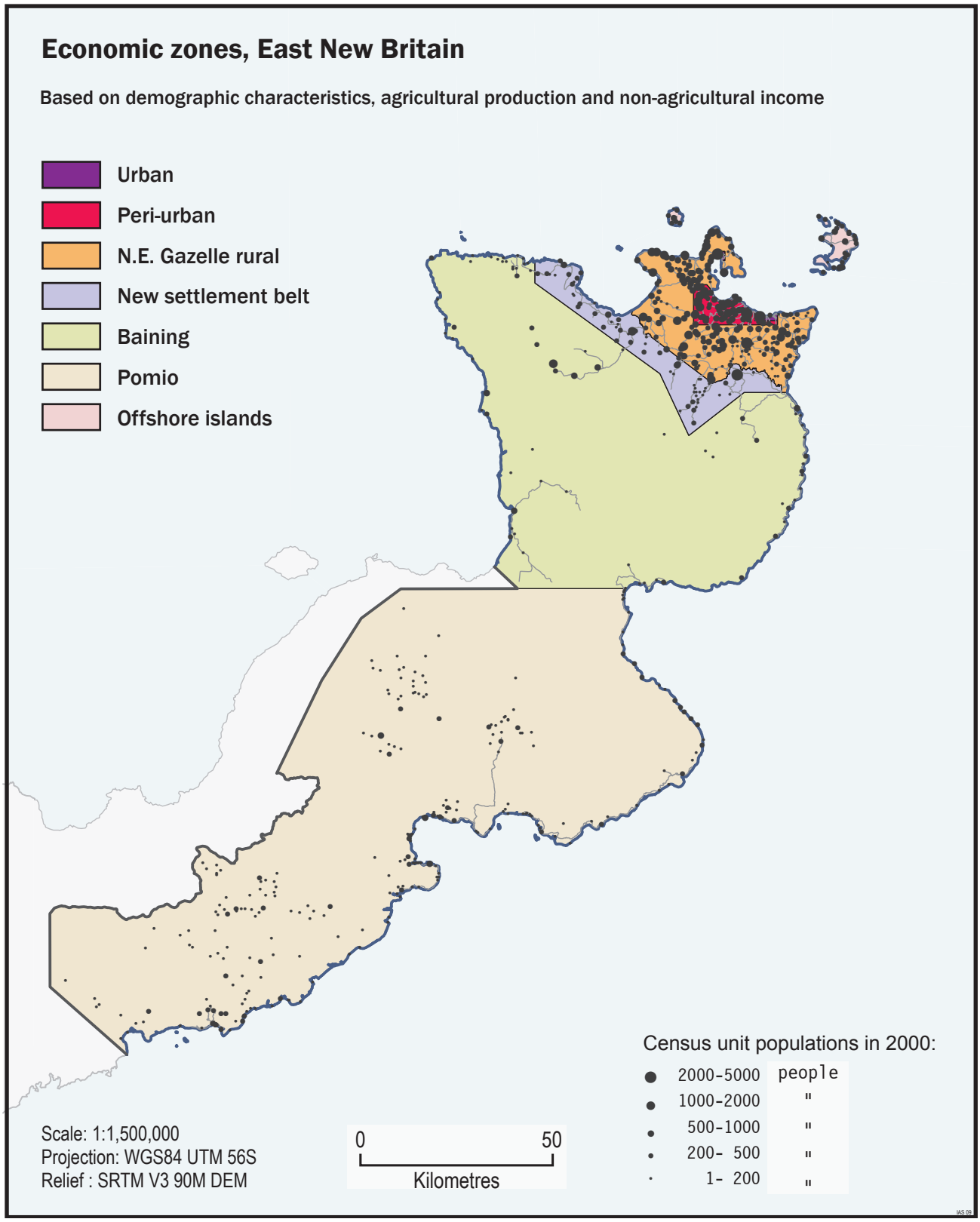


Figure 4. Economic zones for transport network analysis in East New Britain. Rural areas near Kokopo have become more peri-urban since Kokopo's post-eruption reconstruction as the provincial capital. Population is most dense in both this area and in the northeast Gazelle rural zone. South of this zone is the rapidly expanding and ethnically diverse new settlement belt, the most dynamic rural area in the province. Beyond the new settlement belt are the sparsely populated Baining and Pomio areas. Urban areas are confined to the Rabaul and Kokopo townships.

Table 1. Socio-economic features and summary statistics for ENB economic zones.

Economic zone	Pop at 2000 census	Pop % of total	Avg ann pop growth %	Area km2	Pop density px per km2	Road density km per km2	Cocoa estmtd prdctn % of total	Cocoa estmtd income Kina per px 2007	ENBPA wages income Kina per px 2009	Features of economic zone
┌ RABAUL	3,907	2	-6.1	5	782	1.9	0	0	21	Urban areas are small, with very high population and road densities. They are economically diverse, and reliant on retailing, services and wages (e.g. ENBPA wages shown). Population has flowed out of Rabaul into Kokopo. These areas benefit from high agricultural incomes in the surrounding rural areas, port economy, some manufacture, and the town-building restoration projects.
URBAN										
└ KOKOPO	4,607	2	2.8	9	512	2.8	0	9	174	
PERI-URBAN	37,731	18	4.2	123	307	1.0	19	527	64	High road and population densities, diverse economy with significant farm and non-farm income. Many people work or market in town nearby, while growing crops in home areas. High growth, affluent.
NE GAZELLE RURAL	95,661	46	2.9	820	117	0.5	48	520	34	Strongest agricultural area, with almost half ENB's population and moderate population and road densities. Cocoa dominates with mix of other cash crops. Moderate non-farm income and econ. diversity.
NEW SETTLE-MENT BELT	17,172	8	6.2	571	30	0.3	24	1,457	24	Low population density and moderate road density. Very high per-capita crop production and income. Low non-farm income. Very high in-migration and population growth. Ethnically-diverse frontier area.
BAINING	12,108	6	1.8	5011	2	0.0	4	334	18	Very low population density and road density. Moderate per capita crop income (mainly around coast), and very low non-farm income. Below average population growth. Disadvantaged.
POMIO	26,391	13	0.3	8746	3	0.0	3	91	40	Very low population density and road density. Very low per capita crop income, and almost no non-farm income. Population growth is almost zero due to high out-migration. Very disadvantaged.
OFF-SHORE ISLANDS	12,376	6	2.3	77	161	0.6	2	159	12	Small areas with moderate population densities, average population growth. Moderately low cocoa and copra crop income, and fishing.
ENB OVERALL	209,953	100	2.2	15,362	14	0.1	100	491	40	Moderate overall population growth, with significant population movement and in-migration in northeast. Strong dichotomy between affluence in the northeast and poverty elsewhere.

1.2.2 Socio-economic landscape zones

Based on field observation and informant's views, the study has categorised ENB into seven broad socio-economic zones (Figure 4). Local level government (LLG) areas were not used as a basis for the economic zones, because they do not correspond well to either the population clusters or regional economic characteristics within the province. The extent of the economic zones was decided largely on the population mapping, cocoa production mapping, field observation and the views of key informants. The features of each zone are summarised in Table 1. This table summarises some of the statistical results from the study. In general the table shows the northeast zones comprise a centre to the ENB economy while Baining and Pomio form a periphery. The study is not concerned with the offshore islands.

Data could not be gathered for economic zone analysis of crop production other than cocoa, and to some extent copra. Location production data for balsa, coffee, timber, niche exports and fresh produce would also have been very useful if it had been available. The study also could not obtain enough data to see more layers of non-farm economy, which would include types of retailing, service industries, manufacture and wage work. The data that was successfully obtained is presented in the discussion of roads and market chains.

Without being able to gauge actual dimensions, it is certain from observation of the landscape and from the available data that the economy gradually deepens and diversifies, with increasing multiplier effects, as one approaches closer to Kokopo. At the other extreme, in the Pomio and Baining areas, the economy is very thin, with little income from cash crops, which in turn prevents further business development in these areas. In addition to this economic topography, Table 1 reveals a striking feature not seen in a conventional analysis by LLG area. This is the transformation occurring in the new settlement belt along the southern edge of the northeast Gazelle, in the lowland Baining area.

Migration, land and economy in the new settlement belt

The very high population growth in the new settlement belt, just over 6 percent per year, is associated in Table 1 with very high crop incomes from cocoa in that zone. At almost K1,500 per person per year, this is almost triple the per-capita income seen elsewhere from cocoa. The new settlement belt is locally a well known feature of the northeast Gazelle, but this is not reflected in provincial government planning. Given that this area has not received attention from policy makers, and will be referred to later in this study, some of the area's dynamics are detailed here.

Settlement in this area began when the Vudal Settlement Scheme was initiated in 1953 on administration land acquired from Baining people. The intention was to relieve land pressure near Rabaul. In the late 1950s further smallholder schemes were started around Warangoi, on land also bought from Baining people.[2] By the late 1960s, the Vunapalading lowlands were settled by blockholders from Tolai areas, and expansion has continued since. This later settlement has been piecemeal and informal.

Two streams of in-migration are contributing to the high influx into the new settlement belt. As the plantations closed in the late 1970s, the labourers, originally from Highlands, Sepik and other mainland PNG areas sought blocks of land from Baining landowners. After the 1994 eruption, PNG mainlanders who lived in the Rabaul town camps have joined this stream. The Upper Warangoi valley, and other areas along the belt have locally become known as "Small PNG" due to the mix of people from all parts of PNG. On the south coast too from Putput to Ili, Sepik and Highlands plantation labourers have intermarried with Baining locals. Not all ex-plantation labourers have moved into new areas. Some have intermarried around old plantations, e.g. at Bitapaka. Others, many now descendants of the original plantation workers, are claiming areas such as the disputed Raniolo Estate as their own. Others yet work for Tolai landowners, who employ labour in their cocoa blocks while they themselves work in non-farm sectors. Currently many people migrating out of Pomio are also employed in Tolai cocoa blocks.

Tolai people are thought by locals to make up the larger flow into the new settlement belt. As noted above, Tolai people have sought land in these areas since the 1950s. Since 1994 land pressure in northeast Gazelle has increased due to evacuation from traditional lands around Rabaul. Pressure is particularly intense now in the Kokopo peri-urban area, as people from around Rabaul have sought land through traditional ties. This pressure is driving spill-over into the new settlement belt, as well as peri-urban infill development. The formal resettlement areas at Sikut, intended for direct formal resettlement of people from Talwat and Matupit (both traditional Tolai areas) are also located in the new settlement belt. Areas of new informal Tolai settlement are found along the Warangoi valley and the Baining foothills to the south.

New settlement is often a part of a larger family strategy. In some cases people rotate between their Tolai land and their Baining block for one or two weeks at a time. In other cases the family splits so that some are stay on the old Tolai land while others farm the new Baining block. The new areas, cleared from bush, often start as family garden plots, since land is unavailable for food gardens in Gazelle due to their use for cocoa and other cash crops such as copra, lowland coffee and balsa. As the productivity for food gardening falls two or three years later, blocks are planted with cash crops. Currently 2 hectares can be bought for about K5000. Prices have risen 3 or 4 fold since the 1990s. Land transactions are recorded at the local LLG office.

Baining people who prefer their traditional lifestyle based on shifting cultivation are moving further into the hills, as they sell off their lowlands. Other Baining people are permanently settling in mixed localities like Sunam and Gaulim, where intermarriage with Tolai people is common. In these areas, ward meetings and local courts are attended by people from mixed ethnic backgrounds, including Highlands, Sepik, Tolai and Baining. These newer 'melting pot' frontier areas are poorly serviced by feeder roads, health and education facilities, and the ethnic diversity springing from modern PNG transmigration, is a challenge to traditional ideas of social order in the northeast Gazelle.

2. Roads and the Gazelle Market Chain

The Gazelle Peninsula is distinctive for its agricultural export economy. The pattern of road development has largely followed the establishment of export crops, firstly copra, then cocoa. In both cases, roads provide the conduit for freighting the crop to the international port at Rabaul. This transport system is the vital intermediate link in the export crop market chain from farm to international markets. Typically the transport links of a market chain are feeder roads, trunk road and shipping point. The characteristic of the Gazelle road network is a tight, quite sharply bounded single cluster of feeder roads, with a very short trunk road to a close-by port.

In addition to their export market chain function, Gazelle roads will be examined here with regard to local market chains and to the economic activity of small business and government. An assessment is made for each activity examined, of the utility of the extent of the road network in relation to transport cost. Analysis is based on geospatial datasets assembled for this study. These include the spatial distribution of cocoa production, copra production, fresh produce market production, government salary consumption, and business locations.

In more remote parts of the Gazelle Peninsula and beyond where the contiguous road network does not reach, coastal shipping is still used to transfer export crops to Rabaul, and for general transport needs. Shipping will be considered further on in this report, in relation to provincial economic development policy and transport strategy.

2.1 Gazelle roads as a colonial legacy

German plantation production began in 1901, and on the eve of Australian military occupation in 1914, German planters had about 265,000 coconut trees on the Gazelle Peninsula, though initially most export was native trade copra (Epstein 1968:9-11, Salisbury 1970:36). Copra is the dried endosperm of the coconut, used mainly for soap and vegetable oil.

Modern settlement patterns in the Gazelle Peninsula were established early in the colonial period. German administration was set up in Kokopo in 1899, but soon after a deepwater dock was built at Rabaul in 1903, Rabaul town was established and became the administrative centre. The Germans began a program of road building about 1896. These new roads radiated out from Kokopo, which remained the centre of the planter economy. At about the same time, rules were introduced that copra sales had to be in cash, so that the historical nexus between cash economy, export crops and roads in the Gazelle Peninsula was firmly established in this early period.

The Australian Mandate, accepted in 1921, did not pursue agricultural development. After the Japanese war, a new generation of Australian administration turned to development, gathering pace in the 1950s. During the Japanese occupation many coconut plantations had been destroyed by allied bombing or conversion to rice farming. Although copra production was supported after the war by the establishment of an early version of the Copra Marketing Board, the emphasis in the 1950s was on a new start with establishment of cocoa as the favoured cash crop for the Gazelle Peninsula. This was associated with new cocoa smallholder settlement schemes around Kerevat and south of the Warangoi River.

Most of the northeast Gazelle road network had been built before 1942, as detailed wartime maps show. The Japanese added the Burma Road near Rabaul using slave labour, and the 1950s cocoa schemes also added some roads along the southern fringes of settlement around Kerevat, Taulil and Warangoi. By the mid 1970s, roads extending further south had been added. The main ones were the road south of Warangoi River to the coast, the road into the Sikut area following settlement expansion into the Baining lowlands; the road from Vunapalading to Lassul which linked the Vunapalading Lowlands coastal plantations into the road network, and the road inland to Malasaet. Most of this expansion was associated with the spread of cocoa. Expansion of the network stopped after 1975. Independence in 1975 also saw the end of the plantations, which were gradually taken over by smallholders. Since 1975, the emphasis has been on upgrading roads, for example by sealing them, rather then extending them. After 1995 and the introduction of the Organic Law on Provincial and Local Level Government (OLPLLG) the budget available to the

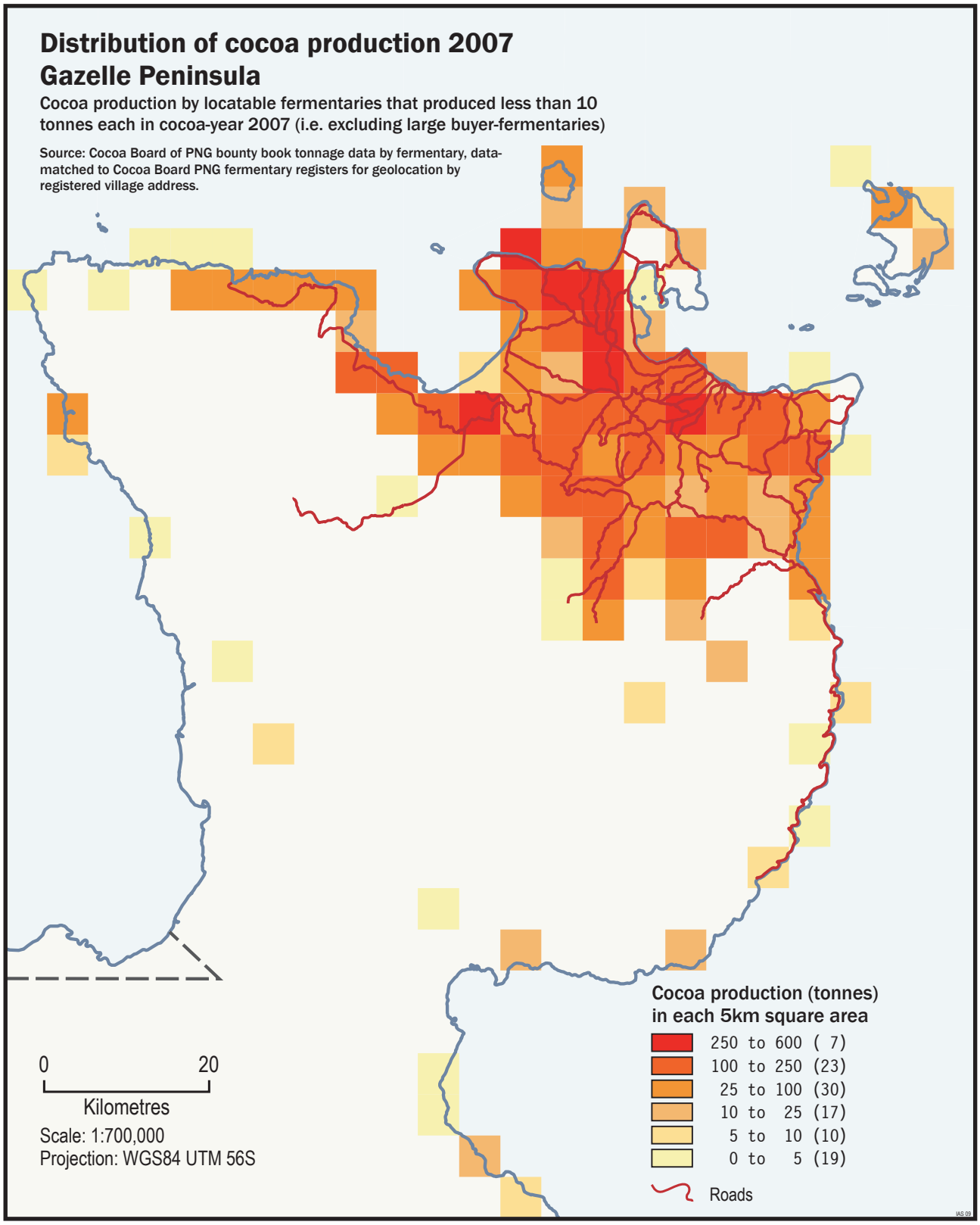


Figure 5. Distribution of cocoa production across the northeast Gazelle. Cocoa, the most important cash crop in East New Britain, is grown right across the road network area and beyond. Production is closely correlated to population distribution. The full road network is used for cocoa transport, except in some inland Baining locations where environmental conditions and road access are poor. This data records production prior to the full effect of cocoa pod borer, which has since lowered production and altered the distribution. Tonnages shown are not total the production, because tonnages from on-sellers, where production location is not recorded, have been filtered out.

Province for incremental sealing has been reduced, according to provincial officials. Funding made available for post-eruption restoration has enabled more road sealing to proceed. Since the 1994 eruption, work on the road network has re-inscribed some roads in preference to others, but has not expanded beyond the pre-existing network.

The recent advent of Cocoa Pod Borer will result in altered crop use in the northeast Gazelle Peninsula. Crop diversification is a likely consequence, possibly with re-entry of organised capital alongside the now-dominant smallholder mode, as seen in the start-up balsa plantation companies now operating, or possibly introduction of oil palm plantations. Local systems of land tenure constrain rapid transition to new forms of agricultural economy, but various ways to overcome these constraints have been tried, with varying degrees of success.

In summary, aside from the minimal expansion on its fringes, the Gazelle road network is a legacy of the pre-war copra plantation days, much of it due to German agricultural development prior to 1914.[3] Use of the roads primarily for the market chain continues, while peri-urbanisation around Kokopo since its post-eruption redevelopment has intensified road use. Cocoa Pod Borer is a major threat to the ENB economy as a whole, and priorities for roads within the traditional Gazelle network may need rethinking if they are to support newer agricultural enterprise.

2.2 Assessment of road utility for the export market chain

Northeast Gazelle produces a wide range of export crops. The major export cash crops are cocoa and copra. Next in economic importance are balsa and coffee. Small volumes of cardamom, nutmeg, Canarium nuts, and essential oils are produced or are currently being developed. In all cases, the crops are transported to Rabaul port, mostly destined for direct international export or in the case of coffee, is transhipped to Lae for processing then export.

Assessment of the utility of the road network for the export market chain here focuses on cocoa and copra production. In cocoa-year 2007/08 the total ENB cocoa production was officially recorded as 17,817 tonnes, with an average Delivered-in-Store price in the same period of K5,789/tonne. The direct return from the cocoa crop into the ENB economy in 2007/08, based on these figures, was about K103M. ENB copra production was recorded as 46,276 tonnes in 2006, with an average Fair Merchantable Standard price that year of K513/tonne. The direct return from the copra crop into the ENB economy in 2006, based on these figures, was about K24M. For comparison, the average annual ENB provincial budget in the period 2004-08 was K82M.

2.2.1 Distribution of cocoa production

While some cocoa is produced in the Pomio region south of Wide Bay and in remote areas of the Gazelle Peninsula, most is produced in the northeast Gazelle area. Figure 5 shows distribution of cocoa production across the Gazelle Peninsula, based on licensed fermentary sales receipts for 2007 which amounted to a recorded 13,250 tonnes. Due to data constraints discussed in Appendix 6, the mapping is based on a subset of these records; 8,000 tonnes from about 3,900 fermentaries for which production was located with reasonable accuracy. Another 4,800 tonnes from 125 fermentaries had to be discounted from the mapping as these were dealer fermentaries, whose ‘production’ was almost all cocoa that they had bought from smaller fermentaries. To include these dealers in the mapping would have distorted the distribution, so they were left out. Fermentary location of a further 300 tonnes production could not be located. Even among the 3,900 or so fermentary records used, some fermentaries are known to have been issued the same licence number as an older fermentary, with confusion as to the proper registered address. This error adds ‘noise’ to the data. Despite these data limitations, the map is thought to represent the geographic pattern of production fairly accurately.

Most noticeable on the map is the strong correlation between the road network and cocoa production. A further, very much smaller component is distributed around remote coasts, relying on shipping or outboard-powered dinghy for transport. Beyond the road network in inland areas, almost no production occurs. Environmental and population factors are at play here as well. Within the road-networked area there are clear production ‘hotspots’ probably influenced by the

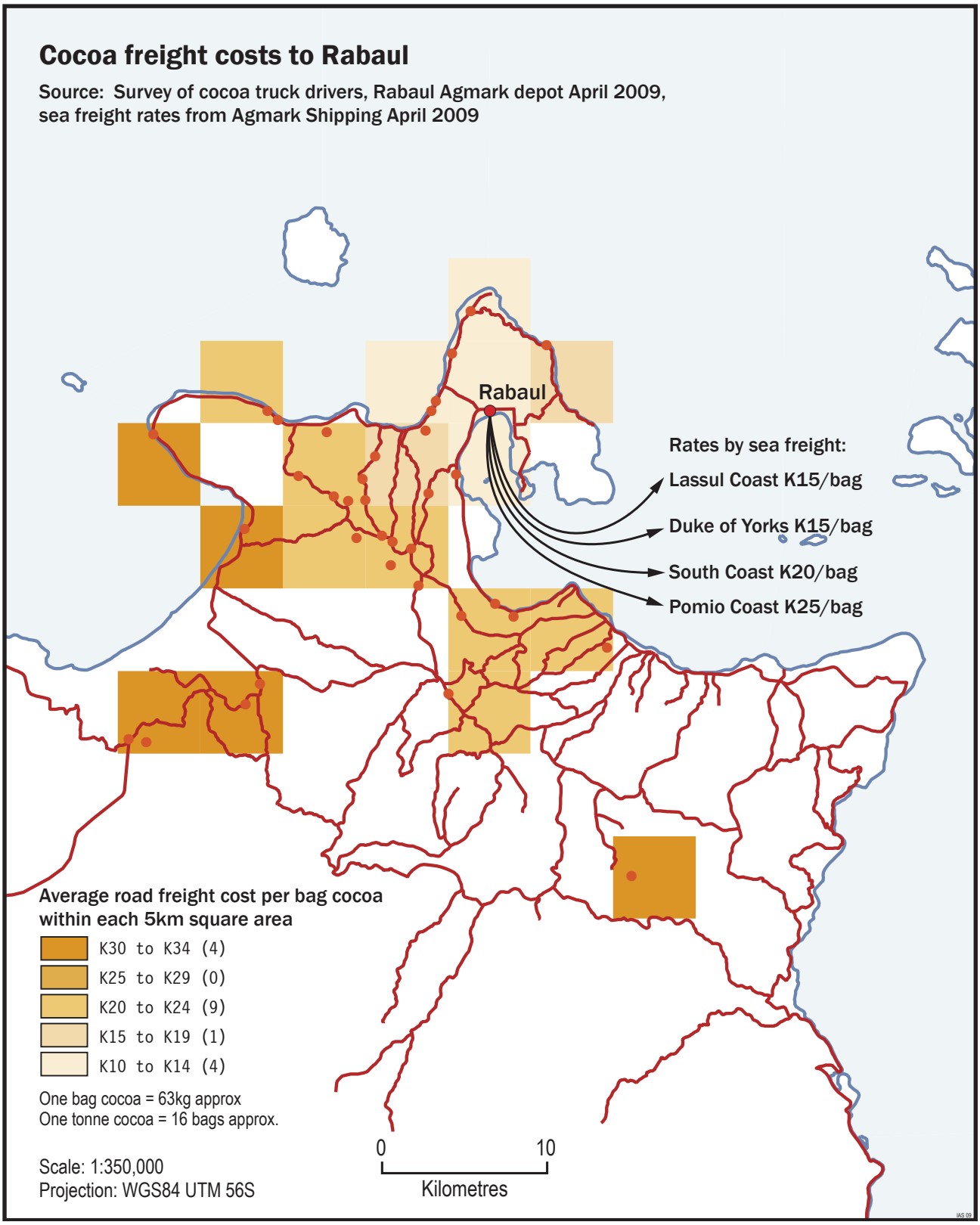


Figure 6. Cost to freight a bag of cocoa to Rabaul from various locations across northeast Gazelle, and beyond. Although this is an incomplete data set, it does indicate that as distance from Rabaul increases, the freight cost rises. Even so, cocoa freight costs are low relative to the value of the crop, and this creates a strong incentive to grow cocoa even in remote areas. Sea freight costs per kilometre to destinations outside the notheast Gazelle are low relative to road freight costs.

combination of environment and population, but overall the spread of production across the road network is widespread and does not fall off with distance from Rabaul port.

2.2.2 Cocoa freight costs

The widespread distribution of cocoa production across the road network, especially given the lack of fall-off with transport distance is likely to be a function of relatively low freight costs. Cocoa in the northeast Gazelle is produced by thousands of farmers, who sell to a variety of dealers in a deregulated market. There are dozens of 'spot buyers' who travel by truck and buy on the roadside. They on-sell the truckload to one of the export agent's depots. There are perhaps twenty of these depots, the main ones being located at Rabaul, Kokopo, Warangoi and Kerevat. Alternatively, the small producer can arrange their own transport and sell to a depot directly. Spot-buyers factor the truck running costs into their buy price. Each depot may have a different daily price, that influences which one the small producers will head to, and the exporter is also factoring in transport costs when advertising a buy price at, say, Kerevat depot. The various possibilities make freight cost mapping difficult.

Figure 6 takes a simple approach, mapping the distribution of freight cost per bag of cocoa charged by truck operators, from various pick-up points to Rabaul. The result, although patchy due to a small set of data, does indicate that while transport costs increase with distance from Rabaul, overall the road freight costs are usually less than K30/bag. This translates to less than K480 per tonne, or less than 10% of the delivered-in-store price of the cocoa. In other words, given the high value of the cocoa crop, the road freight cost is relatively low and in practice does not constrain production. As will be seen below where other economic activities are mapped in relation to the road network, cocoa is unique in fully utilising the whole road network. In this sense, the roads of northeast Gazelle can be characterised as 'cocoa roads'.

The map also shows some sea freight costs, which are on par with road freight costs. Yet, cocoa production in most remote coastal areas is very low. This is a combination of poor shipping facilities affecting shipping frequency and regularity, and of population and environmental constraints.

2.2.3 Distribution of copra production

Distribution of cocoa production across the Gazelle Peninsula was mapped from a complete series of Coconut Products Limited (CPL) weighbridge records for 2008 (Figure 7). The weighbridge records are used for calculating payment to sellers at the mill. Each receipt is issued against a copra seller number, which is linked by computer to a particular person with an associated home address. While there are other copra buyers in ENB, CPL is the largest by far. A greater problem with the weighbridge records is similar to the problem with cocoa receipt records, that although most records are from small producers who bring their own copra to sell at the mill, there are a number of spot buyers who travel around by truck and sell to the mill copra that has been bought from a variety of locations. These dealers were filtered out on the basis of their unusually high tonnage transactions, as explained in Appendix 7. The remainder of the data is thought to be from either individual producers or from 'neighbourhood dealers' who buy relatively small quantities within their own ward area. Offshore producers (e.g. from Duke of York Islands, or those who ship from the south coast) are not represented as their copra comes across the weighbridge typically in a dealer's truck (picked up from the landing), and this dealer tonnage is among that filtered out. Despite the data limitations, the map is thought to be a fair representation of the overall distribution of copra production across the road network area.

The map shows a correlation between the road network and copra production, but it is not as strong as the correlation found for cocoa. In particular, copra is not coming from inland areas. However the production area is widespread along the coast and coastal hinterland particularly from Bitapaka, Toma-Vunamami and Reimber-Livuan-Kombiu. Attenuated inland distribution may in part be due to freight costs but is more likely a legacy of colonial plantation distribution. Coconuts have not been planted in quantity for many decades, so most tree stock is on the old

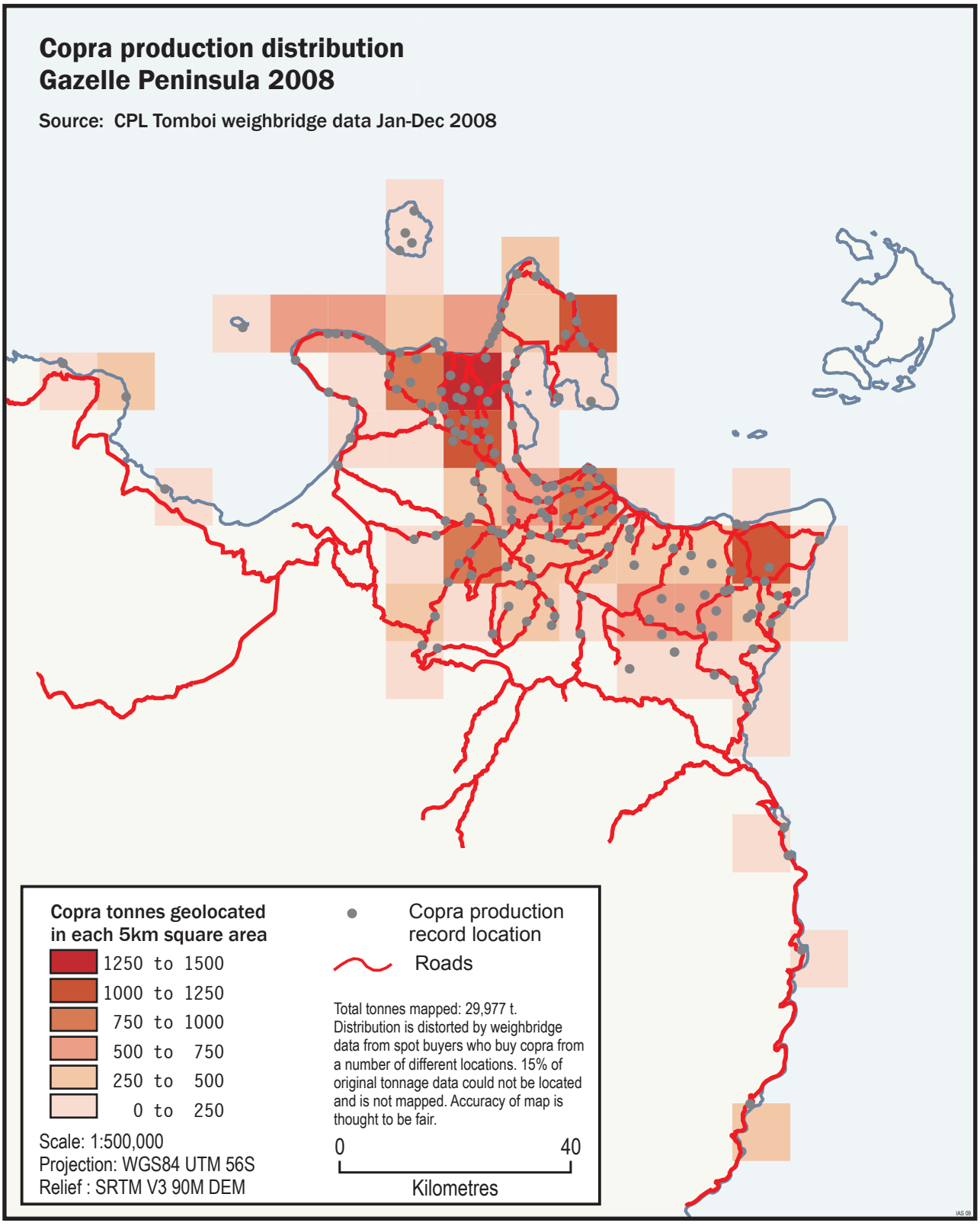


Figure 7. Distribution of copra production in northeast Gazelle. Production is stronger in coastal areas due to both more favourable growing environment and due to the historical location of colonial plantations. Only part of the road network is utilised for copra production. The map was produced from data recorded at the CPL Toboi mill weighbridge, so does not include copra bought by other export buyers. It also does not include copra bought by large on-sellers. Tonnages then are not the total true tonnages produced in each area, but are instead an indicator of production.

plantations, and these were near the coast; which in turn was strongly a function of environment and the extent of the road network at that time.

Freight costs for copra were not systematically surveyed, but of the data collected, costs per bag were about the same as those for cocoa, whether by land or by sea. Freight costs are then roughly between K100/tonne and K300/tonne. However since the sale price is around K500/tonne, longer-distance freight costs become prohibitive. As seen on the map in Figure 7, the coastal and near-coastal roads of the northeast Gazelle are heavily used for transport of copra, as here in particular the crop habitat is suitable and the freight costs are relatively low. Copra production results in semi-widespread utilisation of the road network.

2.3 Assessment of road utility for local produce market chain

The impression in ENB that roads are vital for expanded development arises from the full utilisation of the road network for cocoa transport, and the additional heavy but spatially attenuated utilisation for copra transport, as discussed above. The question arises, whether other economic functions in ENB make similarly extensive use of the road network and would therefore expand if the network were expanded. At the heart of this question is the theory that 'if you build the roads, then development will come', which is a prevalent idea within ENB though is not now dominant thinking in AusAID. The question is addressed by looking firstly at local produce marketing in relation to roads, then at indicators of service and retail economic use of roads.

2.3.1 Local Markets

Moderate to large sized local markets are found in three locations in the Gazelle Peninsula. Kokopo and Rabaul markets are the largest, while a much smaller market is found at Kerevat. These urban markets are provincially managed and attract sellers from a variety of locations. Warangoi market was also surveyed, as it is the largest of the informal markets. There are many more informal markets, located by the roadside or at road junctions, which are operated as family concerns or by groups of neighbours.

Many marketers arrive at the three urban markets by public transport. This includes minibuses that have government-regulated routes and fares, and a variety of tray trucks or utility vehicles with seats in the back, which operate informal routes. The analysis looked at the distribution of marketer's home location (from where they had travelled into market) in relation to fares.

Simple snapshot surveys were taken at the markets in March-April 2009. The surveys were intended to discover where each seller was from, along with some details of what they were selling, how much money they said they made in a day, how often they came, and their gender. Each market was surveyed on a single weekday, covering all sellers present. A survey taken over a number of days would have been more accurate, but for present purposes the data is satisfactory, judging by the strong patterns that emerged. The data is summarised in Appendix 8.

Other than size, the markets shared similar characteristics. Most market sellers are women; of the 845 marketers surveyed, 96% were women. The strong gender bias indicates the importance of local markets to women's economic activity. They sell a variety of goods, typically a mix of fresh garden food (fruit, vegetables and tubers), prepared ready-to-eat food, and a scattering of fish, betel nut, and handcrafts.

Most marketers were selling fruit and vegetables (41%), with betel nut (26%) and prepared food (17%) also popular. About two-thirds of urban market vendors reported that they typically earned between K20 and K70 in a day at the market. Being self-reported, earnings data is not very reliable, but the majority of the data fell into this range.

Figure 8 shows the distribution of people marketing at the Kokopo produce markets, by their home location. The Kokopo market was chosen for mapping and discussion because this was the largest market and had the widest-spread distribution of seller's home-location. The map shows that most vendors come to Kokopo market from home locations less than 18 km away. For the other markets, the distance that vendors tended to travel was less, but the pattern was similar. The

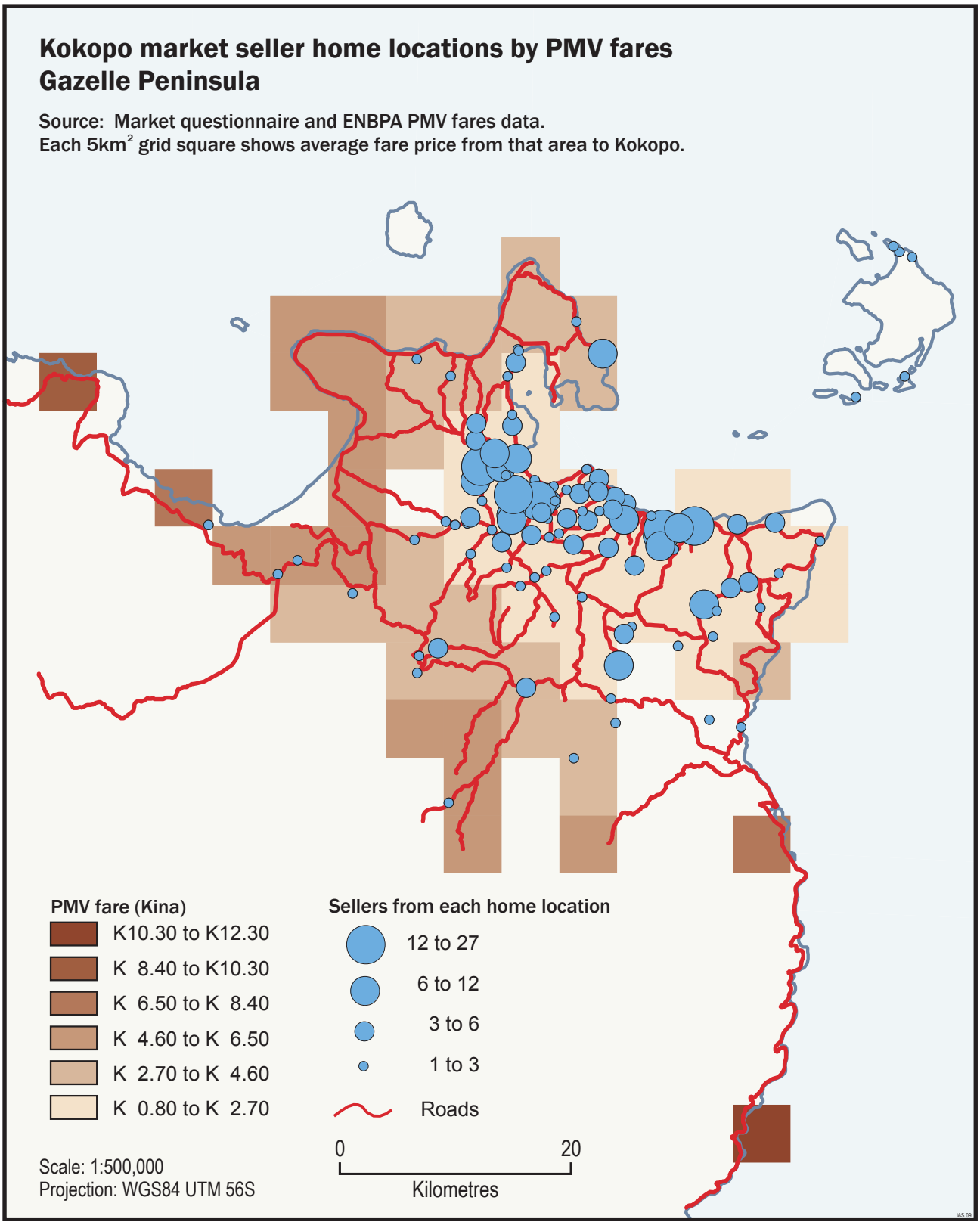


Figure 8. Numbers of sellers coming into Kokopo market from different home locations, related to public transport fare costs. The mapping finds that most sellers come from locations within 18km of Kokopo market. 18km is also the approximate radius of relatively low transport costs. As transport costs to market climb with distance from the market, the number of sellers decreases. This demonstrates that even though the road network is available, it will not be used for economic activity if the cost of freight rises too high in relation to earnings taken. Here is a case that roads are not always a catalyst to stimulate economic activity in remote areas.

distribution of vendors' home location is very concentrated around each market, and does not follow the general population distribution shown in Figure 2. That is, the women who sell at the markets tend to come from relatively nearby locations, while women who live further away tend not to sell their produce at market.

2.3.2 Local markets and transport fare costs

Transport fares to Kokopo were mapped from the official schedule of PMV fare prices. Although this only covers the formal PMV routes and does not cover the informal routes, it is a good indicator of the transport costs paid by the market vendors when they come to Kokopo market. The range of fares paid is shown in Figure 8, using the average fare within each 5km square area. It shows the rate at which fares rise with distance from Kokopo. Within a radius of 18 km from Kokopo, one-way fares charged in March 2009 were at or below K2.70. Beyond 18km the prices continue to rise, until at around 40km distant the one-way fare exceeds K10.

Vendors at the Kokopo market are almost all concentrated with the 18km zone in which the PMV fares were at or below K2.70. They are, in this sense, concentrated in the bottom of a bowl-shaped transport cost gradient. In relationship to market earnings, most vendors say they make at most K70 from a day at the market, so a fare to market of K2.70 then K2.70 back home again, or K5.40 in total, can be about 8 percent of the earnings. This suggests that once transport costs rise above perhaps 5% to 10% of earnings, women choose not to take their produce to market. Further observation may discover other factors also at play, but the spatial relationship between fare costs and vendor's home residence is strong. A similar relationship was found for the other markets.

For local produce markets, only those parts of the road network that are relatively near the market are strongly utilised for market activity. An expansion of the road network is unlikely to result in greater access to markets by sellers in more remote areas. This is because transport costs soon rise to high levels in relation to the value of the goods sold. These costs act as a disincentive for market participation by more remote producers. It is these relative costs rather than a lack of roads that is acting as a barrier to participation in this market chain.

As noted above, there are many smaller markets scattered across the rural road network. These are usually less than a dozen sellers, who are usually from nearby households. A problem for these smaller rural markets is the lack of demand, because fresh produce markets work best where there are many cash-carrying non-farmers (e.g., town wage-earners) who buy rather than grow most of their food. The small rural markets are unable to absorb much supply due to lack of local cash-carrying customers, whereas possibly town the markets could absorb more supply – albeit with downward price pressure. The present situation – where distance-related costs prevent remote fresh produce marketers from access to town markets – could only change if transport costs to town decrease relative to market earnings, or if more cash circulates in the rural areas, generating more widespread demand for fresh produce in smaller local markets.

2.4 Roads for non-farm economy and for services access

Since Independence, northeast Gazelle roads have had an increasing diversity of roles. Two of these are analysed here: non-agricultural economy and services access. Non-agricultural economy refers to businesses such as retailing, service businesses (e.g. mechanics, transport services), social services (e.g. wages earned by teachers, nurses, etc.), and industry. Services access refers to ability to get to services such as education and health facilities. The aim of analysis is, as for the market chain analysis above, to assess extent to which different economic activities use the road network.

2.4.1 Roads in the service economy

To what extent is the road network being used to distribute the benefits of non-farm employment? This is analysed with reference provincial government employees, whose wage employment salary distribution is used as an indicator of the distribution of benefit of services employment to the provincial economy.

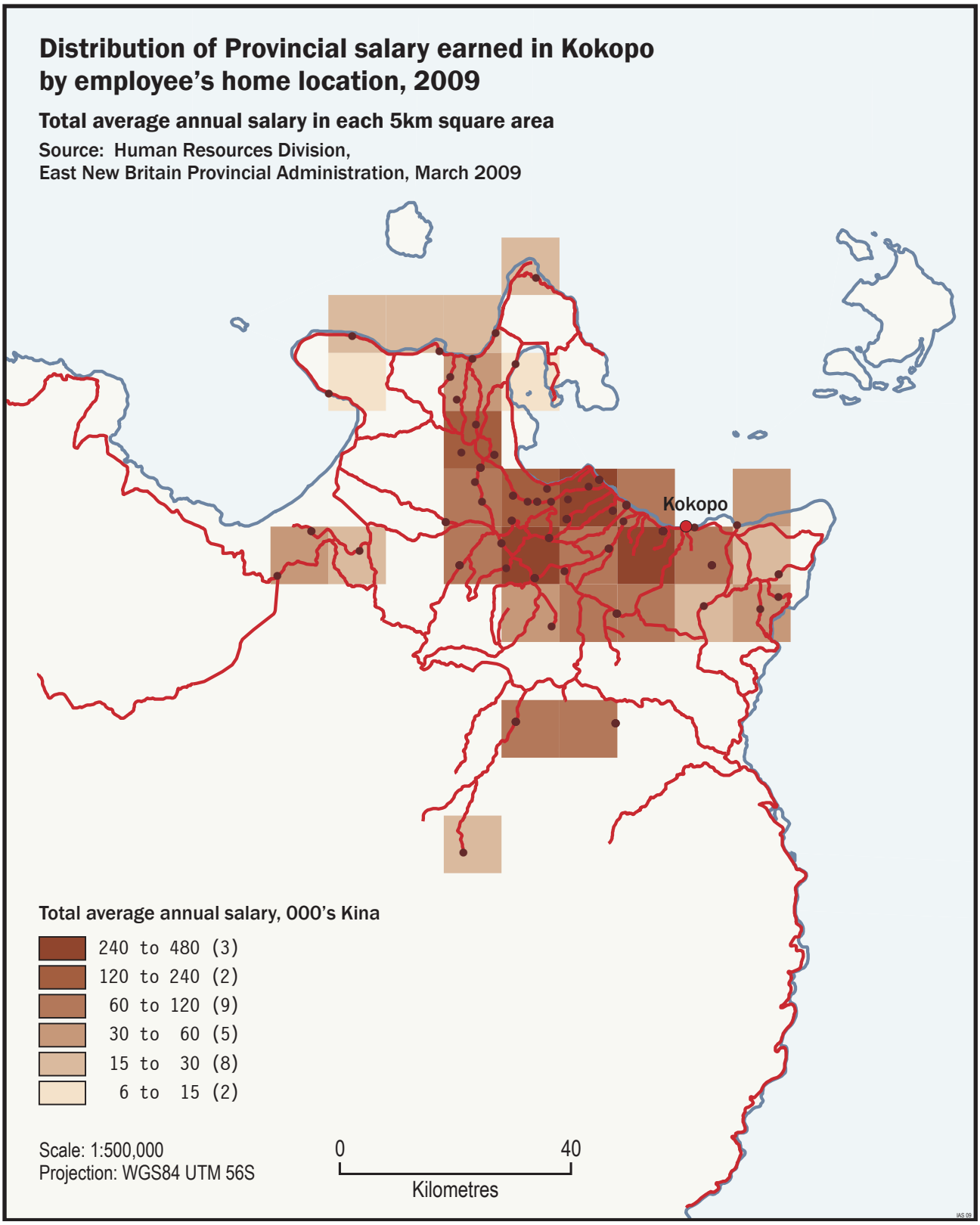


Figure 9. Distribution of provincial employee's salary earned in Kokopo, by employee's home location. Provincial government workers employed in Kokopo are seen here to mostly commute from within a 30km radius of Kokopo, and as a result, the spread of economic benefit from their wages is concentrated in the Kokopo urban and peri-urban areas. Although a wider road network is available, employees do not live further away, mainly because of the commuting time involved. Existence of roads in this case is not stimulating wage economy participation by hinterland regions.

Data was collected in March 2009 for all provincial employees on the ENBPA Human Resources Division's payroll system, 602 in number. Employee number, home village/locality location, work location, and salary range were collected. Data collected was deliberately vague, to protect worker's privacy. From the salary range given for each employee, an average salary was computed, and each location was geo-located. This allowed mapping of the spatial distribution of income into the community from provincial government salaries. Figure 9 shows, where employees working in Kokopo take home their pay (employee's home location), or in other words it notionally shows where and how much pay is taken home. Within each 5km square on the map, the average annual salaries of all worker living in that square are summed together to arrive at the total salary earned by workers living within that home locality.

The map in Figure 9 shows that despite the extensive road network, most workers live relatively close to their work in Kokopo, so most Kokopo-earned salary falls within a radius of about 30km from the town. This is roughly the peri-urban economic zone identified earlier in Figure 4. Beyond this, government salaries earned in Kokopo have little impact since workers do not commute beyond 30km or so. Beyond 30km, commuting time increases to levels that most people find impractical. This demonstrates that despite availability of the wider road network, it does not present people living distant from town to participate as wage-earners in the service economy unless they move closer to work.

Mapping was also made of all 602 records to see the total distribution of provincial employee's salaries by their home locations, and by their work locations. Most employees work in Kokopo and Rabaul urban centres, and in this respect distribution is quite centralised. Most of the salary paid by ENBPA to its employees is taken home within the Gazelle peri-urban area, although there is a scattering of much smaller amounts into some rural areas. Overall, the road network is not being used for long distance travel by employees to work. Most salary is generated in the larger urban centres, and is consumed by households in the urban area itself or in the surrounding peri-urban areas. This indicates that extension of the road network will not result in greater opportunities for this kind of work for people in more remote areas.

2.4.2 Roads and non-farm business

Non-farm business includes retailing and other businesses that exchange service for money, such as mechanics and transport services. Data was geolocated for just two business types in this sector: liquor retailing and PMV transport.

Figure 10 maps retail liquor trading, obtained from provincial liquor licensing receipts for 2008. These receipts show business address, which was mapped. Although liquor retailing is more restricted than general trading, coverage is still wide enough to indicate trends in distribution.[4] Figure 11 shows the distribution of PMV licenses, obtained from provincial PMV licensing receipts for 2008. The map shows the owner's address for each vehicle licensed. As with liquor licenses, the distribution is most dense in the urban areas of Kokopo and Rabaul, and declines with increasing distance away from those centres.

These two maps are a small indication of the types of business distribution that could be mapped for the northeast Gazelle if data was available. General retailing and mechanics businesses were mentioned earlier, and could also include roadside markets, petrol retailing, and so on. On the basis of the maps here, it could be expected that the distribution of most, if not all, non-farm businesses will follow a similar pattern: increasing density as one moves closer to the urban centres. Some will have a greater spread into rural areas (such as those shown here) while others such as banks, will have distributions restricted to towns only. As more business types appear closer to the centres, the opportunity for interaction between these businesses, or multiplier effects, also increases. With all this increasing density, diversity and interaction, the economy can be said to deepen as one moves closer to the centres.

How the road network is affecting business distribution in northeast Gazelle is hard assess in comparison to other parts of PNG, because similar data is not available elsewhere. It is very likely that compared nationally, the Gazelle economy remains deeper for greater distances from urban

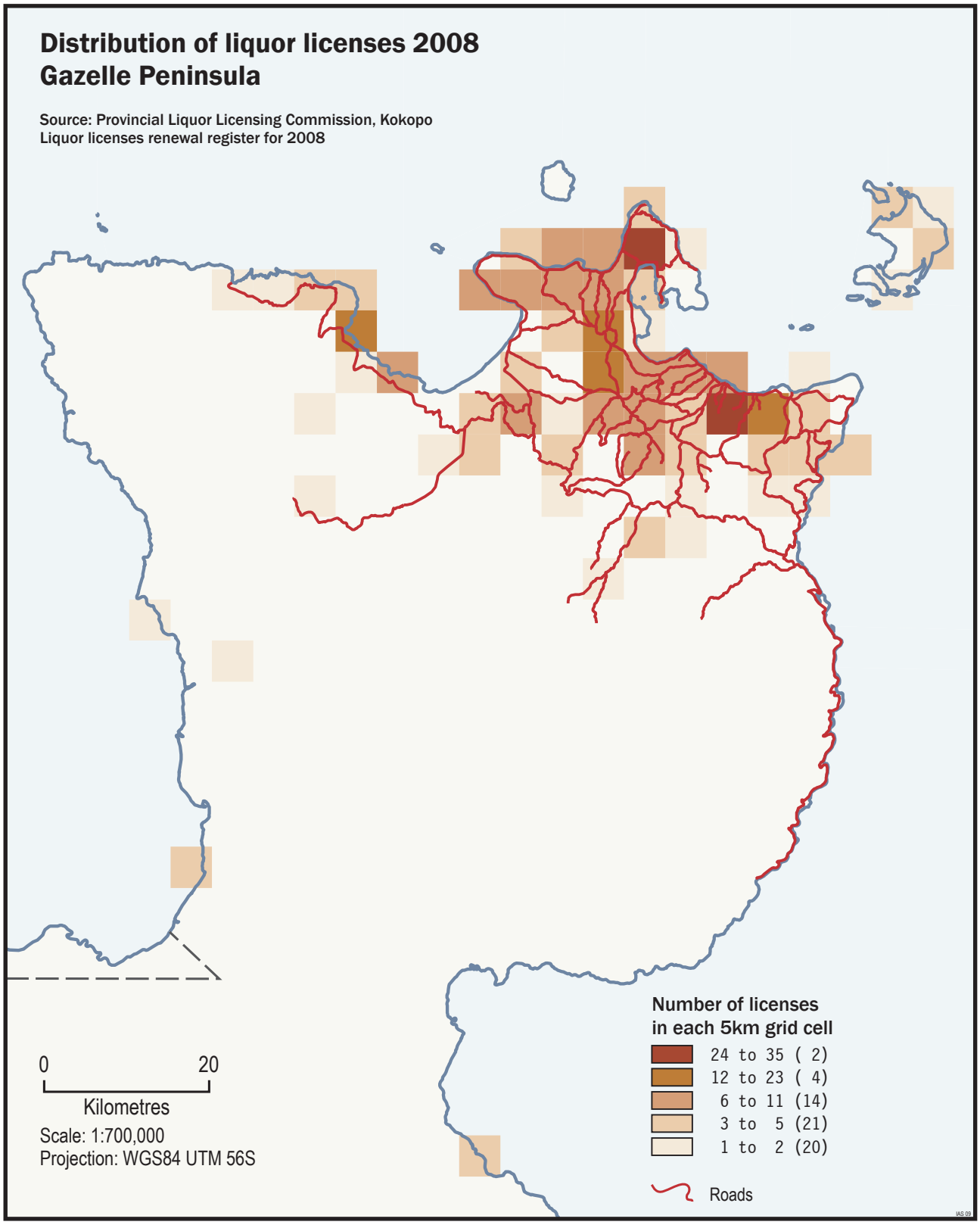


Figure 10. Distribution of liquor licenses in East New Britain. Licenses issued by the provincial government for liquor retailing are an available set of records that indicate the distribution of retail activity more generally. Although we would prefer to know the distribution of general retail stores, the license records for these are hard to obtain. These liquor retailing records have to stand in as a near subsitute for what we would really like to know. They are proxy indicator data. The data confirms that retailing is strongest where income is greatest, due both to cash crop income and overall population numbers. Retail strength is a downstream economic effect of strong cash crop income.

centres, due to the road network. This is in contrast to, say, Bougainville, where the economy quickly becomes much shallower as soon as you leave the towns of Arawa and Buka except, to some extent, along the coastal trunk road.

While the road network in northeast Gazelle is a strong factor in the spread-out density and diversity of business activity, the overall strength of the economy in the area comes from export cash crop income. This is supporting both scattered remote non-farm businesses where people spend money locally and the dense urban economy, where people come for town shopping and business-to-business interaction is also greatest. The roads allow this urban multiplier effect to spread further into the hinterland, but only to an extent, beyond which, no matter how good the roads are, the economy becomes predominantly agricultural. In these rural areas however, non-farm businesses are found only where the cocoa market chain, or another export crop chain, is present. Where market chains are not present, these downstream rural businesses vanish. In summary, provided roads are coupled with crop export, they are vital for rural non-farm business.

2.4.3 Roads for health and education access

Roads benefit education and health service delivery by both providing access by users to the facilities, and access for maintenance and improvement of the facilities. This is particularly important in remote areas, where the challenge is to reduce the time and effort it takes to reach the facilities. On the one hand, students and patients may not attend distant school and health facilities if they are hard to get to, and on the other hand, supplies, staff, and program support tend not to reach facilities that are difficult to access. Figure 12 shows the location of school facilities and Figure 13 shows the location of health facilities, across East New Britain. The data used to construct the maps is found in Appendix 9 and Appendix 10.

Road access to schools was analysed by counting the number of students enrolled at each school, by the distance from the roads. Zones of increasing distance from the roads were created by drawing concentric rings, or buffers, around the map of the road network. These are spaced at 2km intervals. The number of students enrolled in schools (primary, secondary and vocational) was then counted in each zone. Elementary schools were not included because data was incomplete.

The results are graphed in Figure 14. This shows that a great majority of students, about 88% of all students enrolled, attend schools which are within 2km of a road. The very high road access seen here is unusual for Papua New Guinea and is possibly unique to East New Britain. The effect is mostly due to the dense road network of northeast Gazelle. However this is in contrast to a minority of students who attend schools that are up to 40km from the nearest road. Reference to Figure 12 shows that most of these remote schools are found in Pomio district. This is an indication of the strong contrast between two different worlds found in East New Britain: the highly connected and prosperous northeast Gazelle, and the very underdeveloped remote districts which are among the most disadvantaged in PNG (see Hanson et. al. 2001, p.260-68). In the analysis, all roads in the province have been included; if account was taken of roads in poor condition or that are only accessible from outside by sea, then the proportion of schools facing road access constraints, which reflects the situation of Pomio and of the Baining area, would be shown worse.

A check was made on the match between distribution of schools by distance from roads, and the distribution of the population in general. Figure 15 shows population by distance from roads, using the same buffer zones and road map used to analyse schools road access. Again most population in ENB, about 86%, is located within 2km of a road, with a similar fall-off in road access reflecting the lack of feeder roads to the remote low-density populations in the Pomio and Baining districts.

A similar analysis to that for schools was not made for health facilities, since there is no available health data that indicates usage rates of health facilities, particularly the aid posts. Referring to the map of health facilities, a similar pattern to the one described for schools can be expected.

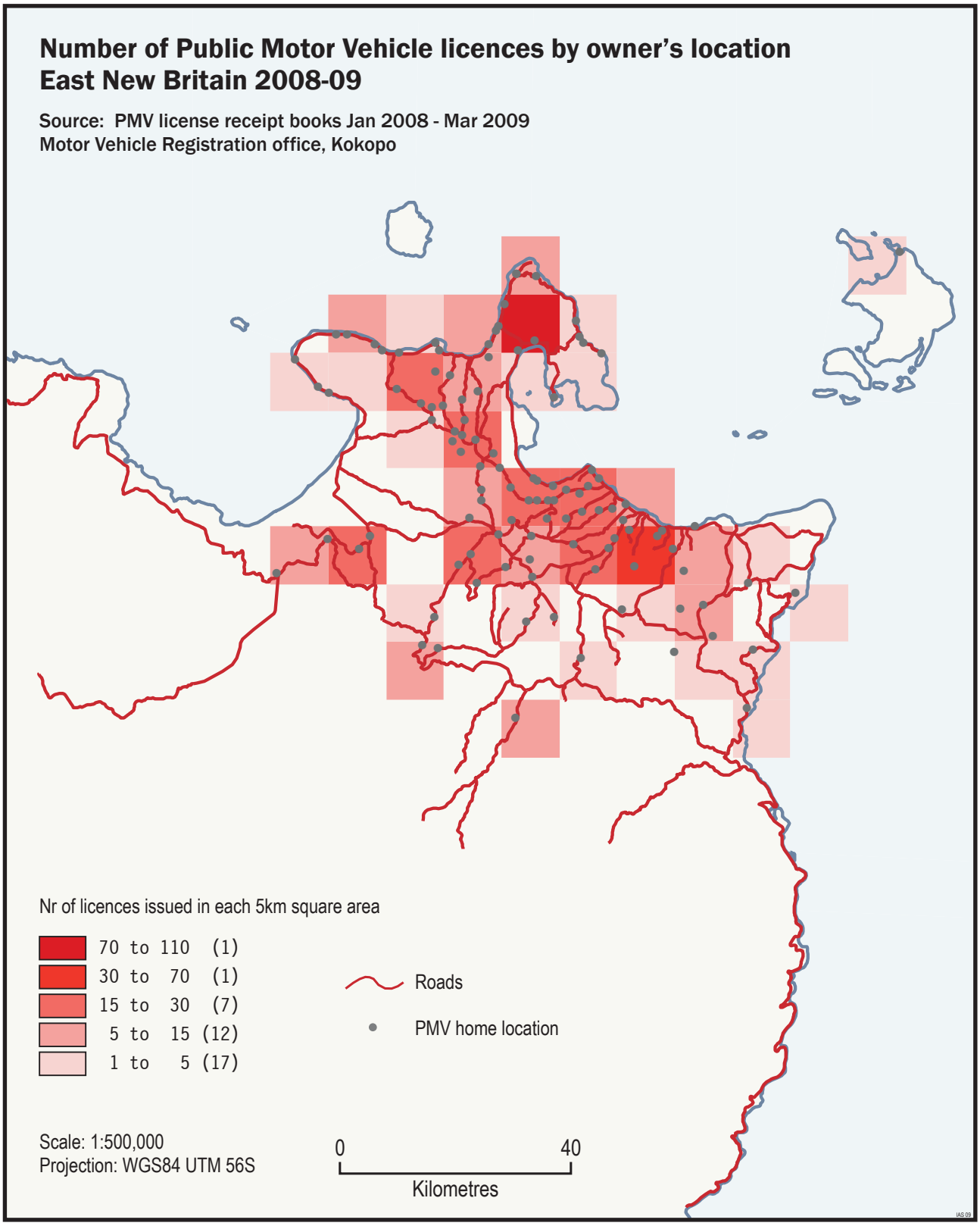


Figure 11. Distribution of public motor vehicle (PMV) licenses in East New Britain. PMVs are one form of non-farm business. Garage address of each PMV is recorded on the annual government license required to operate the vehicle as a PMV. The map of these addresses indicates how income from this layer of the economy is distributed across the landscape. Distribution is concentrated in urban areas and to a lesser extent the Kokopo peri-urban area. Beyond that, PMV businesses fall away. It is an example of the greater diversity and depth of the economy found closer to the main centres. The road network helps spread out the concentration, but only to an extent.

2.5 Market chain lessons and conclusions

The road network in the northeast Gazelle Peninsula was built initially to bring copra from coconut plantations to Rabaul port. The road network was later extended as part of efforts to support cocoa production. Both these crops do well in most of the northeast Gazelle environment. Mapping of crop production shows that cocoa makes use of almost the entire northeast Gazelle road network. This is attributed to the low cost of transport in relation to sale price of the cocoa, usually less than 10%. In other words, cocoa is a high value crop, with relatively low freight costs. Profitability is therefore high and, since the environment is favourable, cocoa is grown and transported across almost the full road network.

In the case of copra, production is less widespread, correlating mainly to the old colonial plantation areas that tended toward a coastal and near-inland distribution across the northeast Gazelle. Copra does not fetch the same high prices as cocoa, so the cost of transporting copra to market is higher relative to the market price. In those areas where it is grown in the northeast Gazelle, freight consumes about 20% of crop earnings. While environmental, historical and labour-cost constraints are also present, in part the reason why copra production uses only the road network near the port is because of its lower crop value, with relatively high freight costs: profitability falls off quickly with distance from the port.

It was found in the case of local produce market sellers that they did not travel from afar to sell at the markets. Transport costs to attend the market rose with distance from the market. Analysis showed that once transport costs reached about 5% to 10% of earnings, market participation fell off. While roads existed to bring the market sellers in, it is these relative costs of transport to earnings, rather than the existence of roads, that is acting as a barrier to participation in the local produce market chain. Again, fresh produce uses only part of the road network because of lower crop value, with relatively high fare costs: lower profitability with distance from market is the key factor.

In the case of government employees, it was found that they tend not to commute more than 30km to work. Beyond this distance, most people find the commuting time to be impractical. Most government work is located in town, either Kokopo or Rabaul. Despite the road network extending further, it does not present an opportunity for remote people to participate as wage-earners in the service economy unless they move closer to town.

Mapping of access by roads to schools and health facilities has shown how, in the case of the northeast Gazelle, road networks built primarily to service cocoa and copra production have a strong secondary benefit for social services. Almost all these facilities in the northeast Gazelle are within 2km of a road, an almost unique situation in PNG. However, beyond the northeast Gazelle area, access to these facilities is much worse where the nexus of crop production and roads is not present. In Pomio particularly, feeder roads built with market chain development in mind are needed if Pomio is to benefit from a similar pattern of secondary use of roads for health and education access.

The examples given above of road transport costs to income benefits indicate something often lost sight of in discussion of roads and their potential to stimulate economic development: roads are utilised only to the extent that the costs associated with transport are perceived as relatively low in comparison to the benefit obtained. In other words, the analysis shows that roads are used extensively only if:

crop value is relatively high, and freight cost is relatively low = smallholder profitability

The lesson here for roads in market chains is that building roads alone cannot create economic growth. Rather, roads only create growth if they tap an opportunity for profit. This is an important lesson when thinking about roads and their role in generating economic growth. New thinking for market chains in ENB is becoming increasingly necessary, given the major threat that Cocoa Pod Borer now poses to the ENB economy. Priorities for roads within the traditional Gazelle market chain may soon need redefinition if they are to support newer agricultural enterprise.

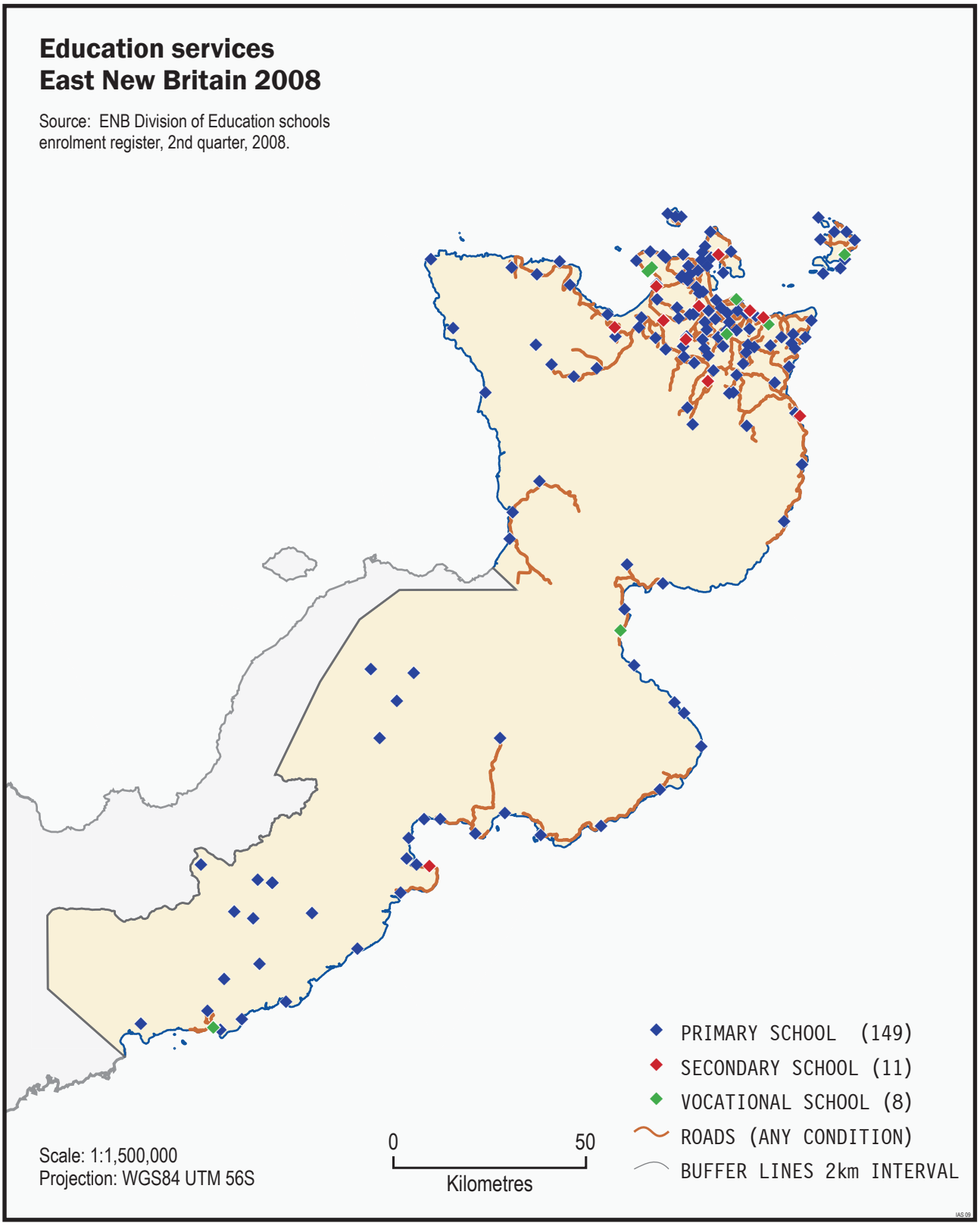


Figure 12. Distribution of schools in East New Britain. In the northeast Gazelle, schools are all within 2km of a road. Many schools around other parts of the ENB coast are also close to roads, although condition of many of these roads is poor and they rely on shipping access. Inland Pomio areas have no roads access to schools.

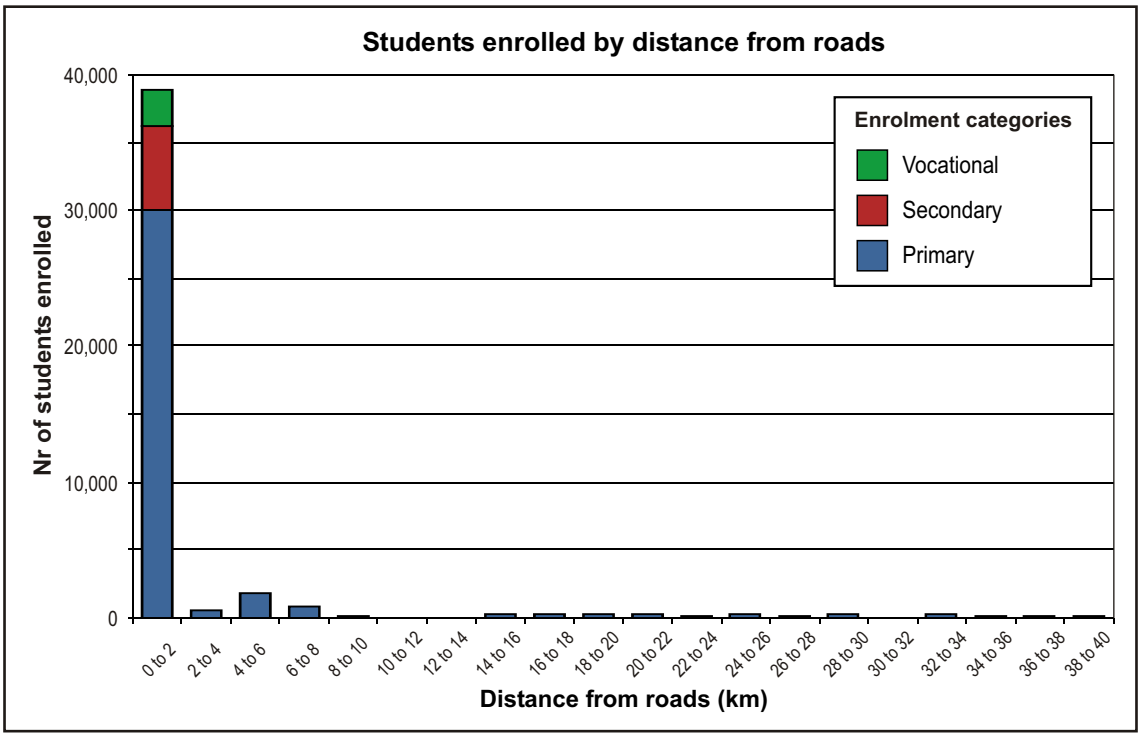


Figure 14. Distribution of school enrolment numbers by distance from roads, ENB. Most students attend schools that are within 2km of a road. This reflects the intensity of the road network in the northeast Gazelle, where most people live. Most students in the Pomio and Baining areas attend schools that are far from roads. This lack of access compounds the disadvantage of those areas.

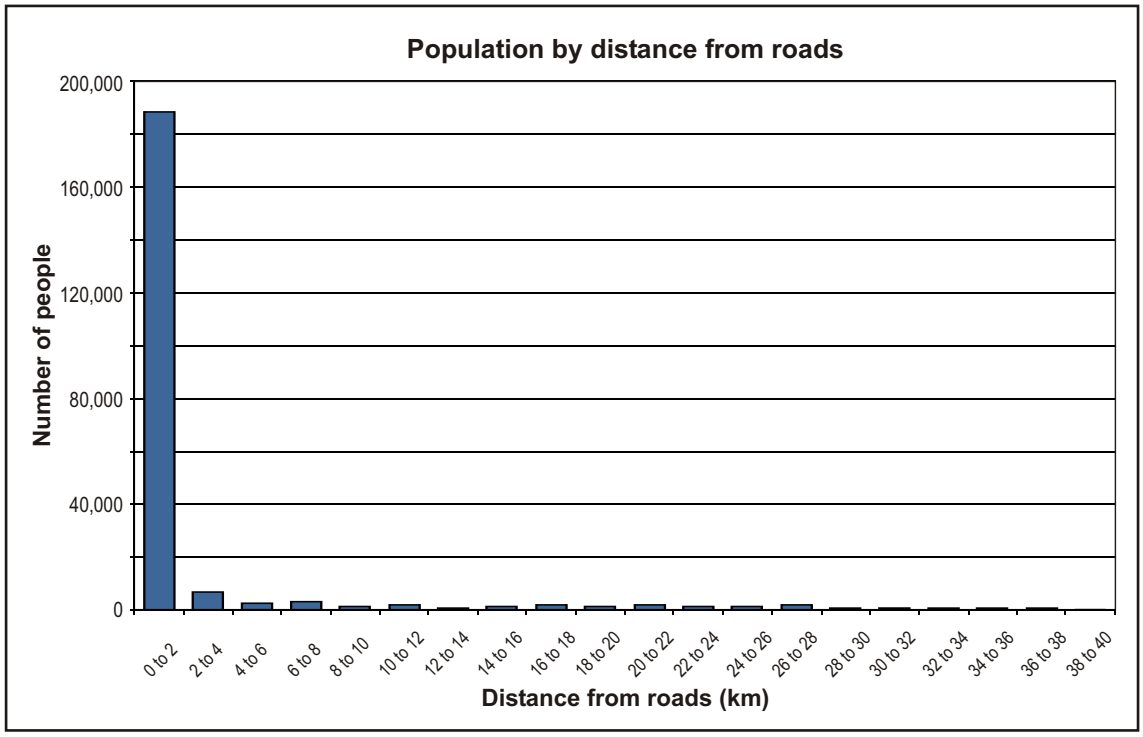


Figure 15. Distribution of population by distance from roads, ENB. Most people live within 2km of a road, reflecting the density of the northeast Gazelle road network, while in remote Pomio and Baining areas many people live far from roads. This patterning shows that school distribution generally mirrors population distribution.

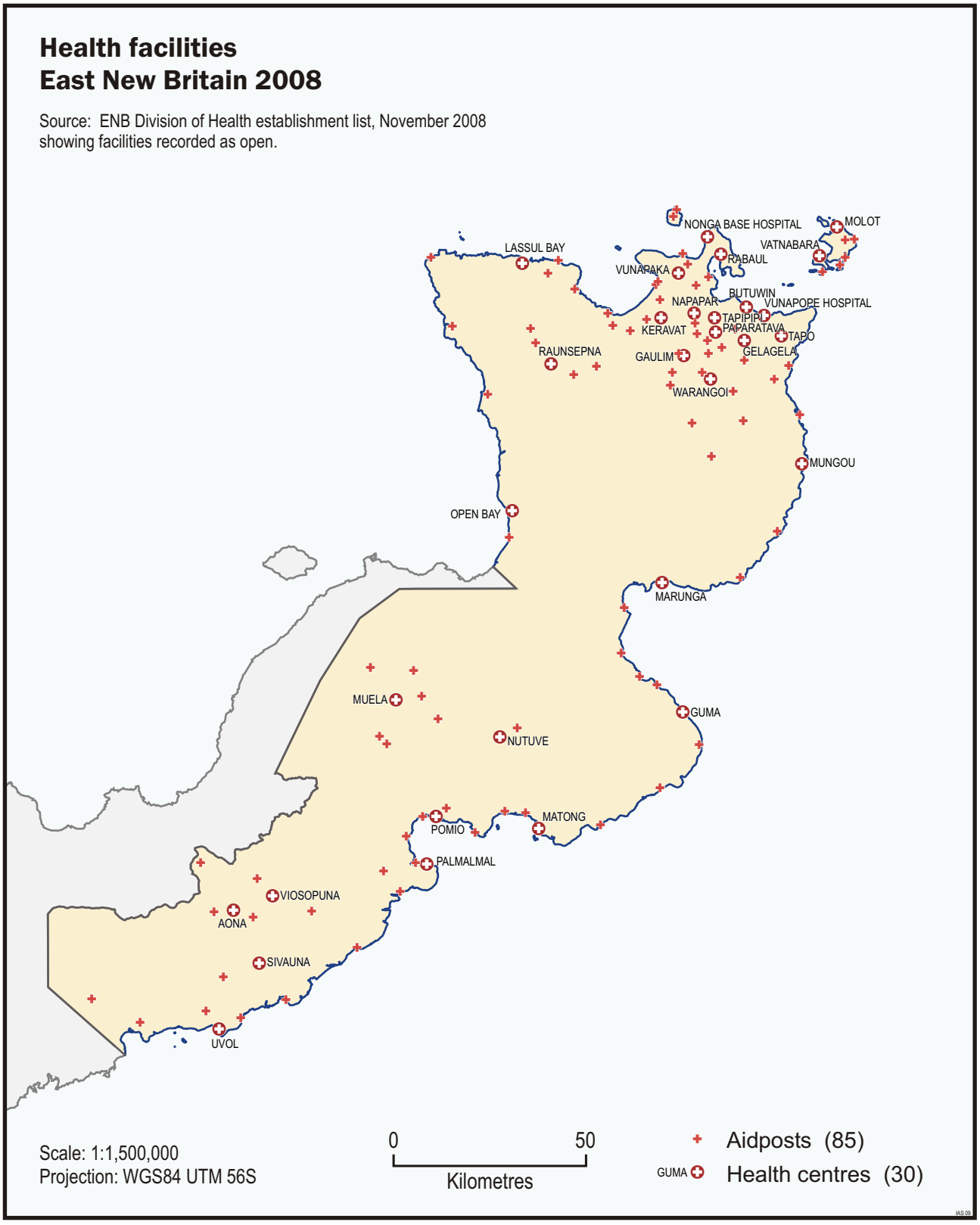


Figure 13. Distribution of health facilities in East New Britain. Generally, the distribution of health facilities reflects the distribution of population in the province. Health facilities outside of the notheast Gazelle area are usually far from any road, which makes access by patients difficult, and makes access for maintenance and improvement of the facilties difficult as well.

3. Roads and post-eruption restoration

This section assesses the impact of roads restoration after the Tavurvur and Vulcan eruptions, in the vicinity of Rabaul, which occurred in September 1994. Roads restoration occurred within the much wider post-eruption Gazelle Restoration Program. The program was an example of natural disaster rehabilitation.

The extent and depth of ashfall from the eruptions is shown in Figure 16. While all of Rabaul town was affected, the eastern side of the town was almost completely destroyed. Buildings were destroyed by roof collapse under the weight of the falling ash. The provincial government offices were among the buildings completely destroyed. 28,000 people were evacuated to care centres in early 1995.[5] Between 20,000 and 30,000 people were permanently displaced. Damage was estimated at USD280M.[6]

After the disaster, the Government of Papua New Guinea was supported by multilateral donors in restoration of the northeast Gazelle area. Resettlement of affected people into new areas away from volcanic hazard and the relocation of much of Rabaul's urban functions to Kokopo were the main long-term focus of the restoration. A move of government functions to Kokopo had already been mooted in 1984 disaster planning.[7] This disaster planning in the mid 1980s was based on concurrent vulcanological risk assessment (McKee et. al. 1985) which saw future destruction of Rabaul as almost inevitable.

To accomplish the restoration, the Gazelle Restoration Authority was established in February 1995. Its implementation unit opened in May 1995.[8] By March 1995, land had been bought by the ENB provincial government for resettlement at various sites in the Warangoi valley, for township development on Baliora plantation, and for industrial estate development at Takubar. The Kokopo urban development plan was prepared in early 1995 also.[9] While these responses were quick, they were also in the heat of the moment rather than based on land acquisition for such purposes in anticipation of such a disaster.

The goals and main objectives of the restoration program are summarised in schematic form in Figure 17. This schematic of the fundamental program strategy was interpreted in retrospect from the GRA mission statement, the various objectives of phases of the program, and consideration of actual projects implemented.

Implementation of the Gazelle Restoration Program under the GRA was planned as three stages: Immediate Term Restoration Program (ITRP, 1995-2000), Medium Term Restoration Program (MTRP, Phase 1 2000-2008, Phase 2 2008-2010) and Long Term Restoration Program (LTRP). A total of K426M will have been spent under the ITRP and MTRP by 2010.

The ITRP, based on the AIDAB Rabaul Volcanic Disaster Needs Assessment Mission report of November 1994, focussed on three main objectives. In brief these were:

1. Establish resettlement estates; expand Kokopo Town and establish Baliora Town
2. Restore the west side of Rabaul Town ('sector one') for port services
3. Upgrade existing facilities and transport infrastructure to cater for the population shifts.

Drawing from the GRA expenditure data presented in Appendix 11, during the ITRP K30M, or 14% of total ITRP expenditure was for permanent roads, with another K10.9M (5% of total expenditure) spent on emergency roads. World Bank and AusAID were the major roads donors. Following the ITRP, the MTRP was initiated in 2000. The MTRP objectives in brief were:

1. Improve quality of life for displaced communities
2. Consolidate Kokopo as the provincial capital
3. Restore sections of Rabaul Town for port services
4. Develop infrastructure and services in hinterland centres
5. Longer-term economic diversification and institution building.[10]

The major single expenditure during MTRP-phase1 was roads, with K95M spent (48% of total expenditure, see data in Appendix 11). The main contributors to roads during this phase were

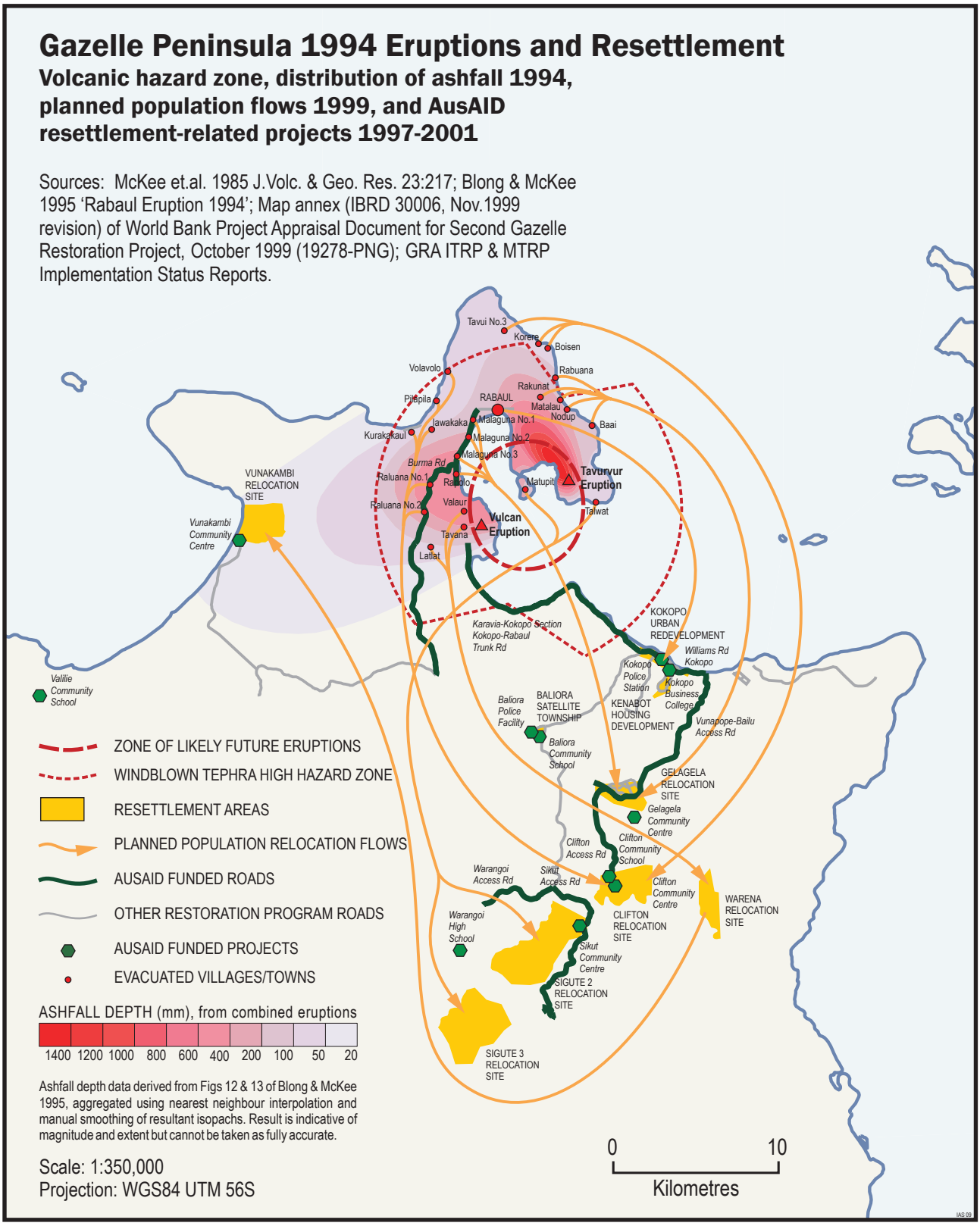


Figure 16. Gazelle Peninsula 1994 eruptions and resettlement. Ashfall depth from the combined 1994 Vulcan and Tavurvur eruptions indicates the areas most affected. This mirrors the hazard zone for southeast windblown ash (tephra), as marked by geologists. The hazard zone also includes an area that would be affected if eruption occurred during northwest winds. Post-disaster policy was to resettle people away from these hazard zones. Formal resettlement areas are marked in yellow. International donors, including AusAID, provided funds for associated infrastructure. AusAID resettlement projects and roads are shown in green.

World Bank, AusAID and GoPNG. Overall Gazelle Restoration Program funding by sector during the 1995-2008 period is shown in Figure 18. This shows that roads constituted a third of all restoration funding. Figure 16 shows roads upgraded by AusAID and other donors during the program; although those upgraded by other donors may not all be shown.

3.1 AusAID roads in post-eruption relocation

AusAID was a major funder of the Gazelle Restoration Program, contributing one quarter of all funding (Figure 19). Other major funders were the World Bank and JICA (Japanese aid). The World Bank and AusAID contributed a wide portfolio of project funding, while JICA spent mostly on Tokua airport construction. Figure 16 maps AusAID projects including roads, against the area affected by the eruption and the planned resettlement population flows. Figure 20 illustrates the breakdown of AusAID expenditure by sector. Table 2 is a detailed list of the AusAID road projects within the Gazelle Restoration Program, while Figure 21 charts AusAID road expenditure. In summary, the road projects AusAID funded with the program were:

- The main road through Kokopo (Williams Rd)
- Roads leading from Kokopo to the resettlement areas
- Most of the Rabaul-Kokopo trunk road
- A segment of the Rabaul-Kokopo alternative route via Burma Rd

AusAID has provided assistance for ENB road infrastructure in three periods since the 1994 eruption. Initially, under the ITRP (up to December 2000), AusAID funded the restoration of five roads to the value of K20M. These roads were one component of the AusAID Roads, Police & Education Infrastructure Development and Upgrading Project.

Secondly, during the MTRP, between 2001 and 2003, AusAID funded roads to the value of K37M. K4.1M of this sum was funded under the AusAID East New Britain Road Maintenance Project (ENBRMP). However the largest component of this second period was funding of 19.3km (69% of the total length) of the Kokopo-Rabaul Road, to the value of K27.7M. This, and the associated Burma Road (K7.4M), was funded under the AusAID Gazelle Road Restoration Project. That is, roads were funded under three separate AusAID activities between 1995 and 2003, to a total value of K57M. Table 2, then, is a list of all these road projects.

The third episode of roads infrastructure spending by AusAID in East New Britain was not implemented directly as an AusAID activity but as a component chosen by the ENB Provincial Administration (ENBPA) under the Provincial Performance Improvement Initiative (PPII), which in turn was supported by the AusAID Sub-National Strategy (SNS). Road works have been undertaken under the PPII from 2005 to present, with spending to end of 2007 being K2.2M, and a further allocation of K0.9M in 2008. The PPII roads are considered separately, below.

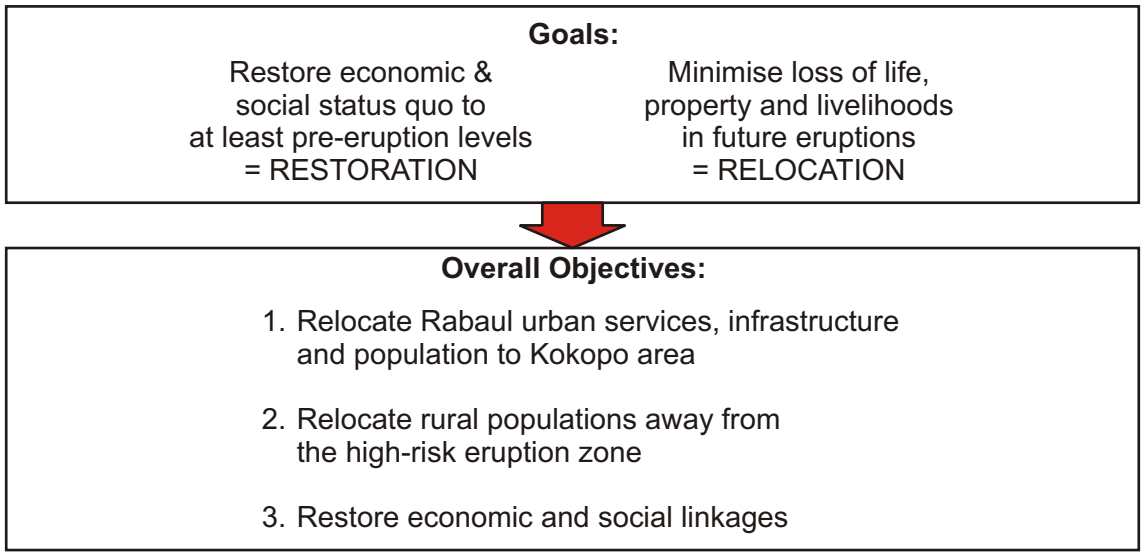


Figure 17. Gazelle Restoration Program strategy, seen in retrospect.

Table 2. AusAID restoration roads funding.

Road	Funding (PGK)	Length approx (km)	Program
Kokopo town main road (Williams Rd)	14,977,149	4.5	ITRP
Warangoi access road	1,000,673	5.1	ITRP
Vunapope-Bailu (Gelagela) access road	2,109,159	12.6	ITRP
Sikut resettlement access road	568,110	10.9	ITRP
Sikut resettlement internal roads	1,283,560	1.8	ITRP
Clifton resettlement access road	561,782	7.3	ITRP
Burma Rd - Rakunai to Raluan to Burma Jnctn	7,352,984	6.3	MTRP
Kokopo-Rabaul Rd - Tunnel Hill to Rapolo	included above	3.7	MTRP
Kokopo-Rabaul Rd - Karavia to Kokopo	24,977,957	15.6	MTRP
Rakunai to Navunaram (ENBRMP)	2,737,290	2.2	MTRP
Navunaram to Vunadidir Jnctn (ENBRMP)	926,863	6.8	MTRP
Other ENBRMP maintenance	348,631	-	MTRP
Total	**56,844,158**	**76.8**	

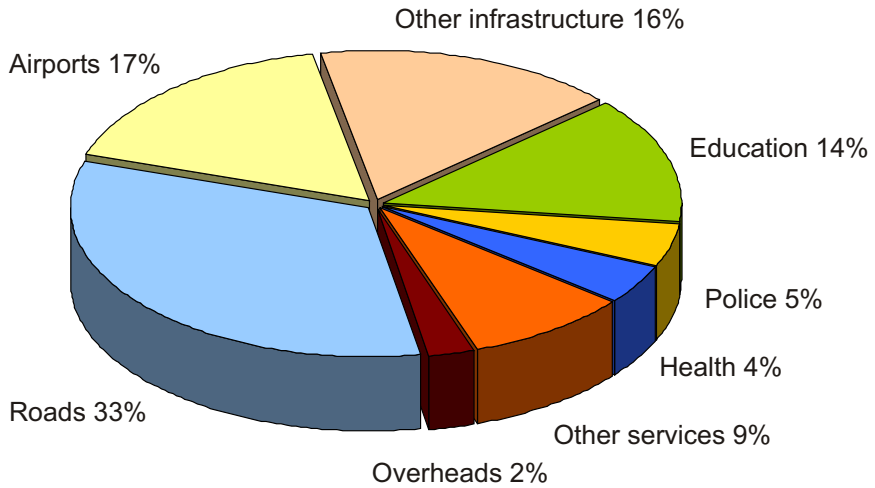
Source: GRA ITRP and MTRP itemised project expenditure spreadsheets, lengths estimated from GIS road mapping.

3.2 Intention and effect of the restoration roads

The retrospective view of the Gazelle Restoration Program strategy presented in Figure 17 makes clear the intent of roads within the program. Roads were the principle means by which to relink the relocated services, infrastructure and population that were dispersed from Rabaul by the restoration program. The intent was not primarily to stimulate new economic growth. The relinking role of roads was mostly achieved by upgrading existing roads. These include:

- Kokopo-Rabaul road
- Burma Road
- Roads south to the formal resettlement areas
- Kokopo urban roads
- Roads to other relocated facilities, e.g. airport

As noted above, AusAID was involved in all but the last of these. The primary function of the Kokopo-Rabaul road is transport between Rabaul port and relocated businesses that have now set up in Kokopo and its nearby industrial estate at Takubar. Its secondary intended function is escape from Rabaul in event of re-eruption. In addition this road is also used to freight export crops from the rural hinterland to the port; a function that it had prior to the eruption event.



ITRP and MTRP-Phase1. Source: GRA ITRP and MTRP itemised project expenditure spreadsheet data, recalculated. Note that "Other infrastructure" includes sea transport, land development, electricity, water, sewerage, solid waste & communications. "Other services" includes volcano monitoring, fire service, community development, primary & secondary industry support services "Overheads" includes administration & preparation studies.

Figure 18. Funding by sector, all donors, Gazelle Restoration Program 1995-2008.

Burma Road leads inland away from the Vulcan eruption and is another of the 'escape' roads. It also forms part of an inland alternative route between Rabaul and Kokopo that can be used if the main road is cut by eruption or mudflows. These two routes, the Kokopo-Rabaul road and the Burma alternative route were modelled for cost-benefit analysis and transport flows prior to upgrading.[11]

Roads to resettlement areas and other dispersed facilities function as access to these, while Williams Road (the new main road through Kokopo) and new urban side-roads within Kokopo are essential for traffic circulation within the redeveloped urban centre of Kokopo and its new industrial suburb of Takubar.

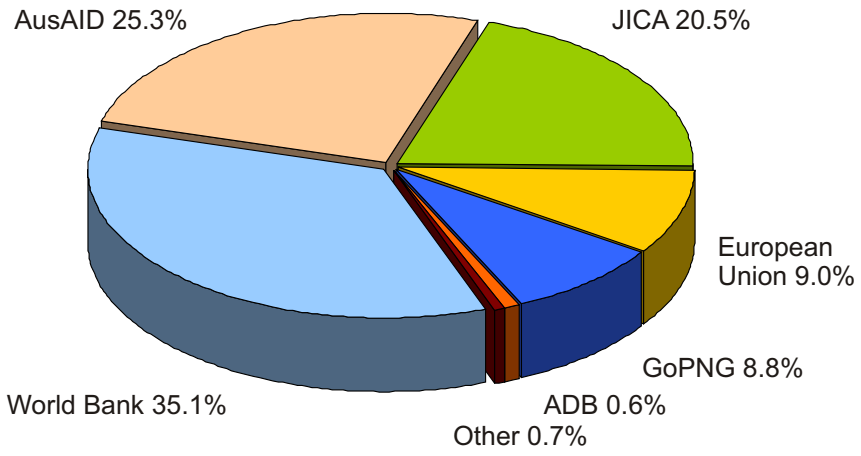
Given the intent to use roads primarily for relinking the broken-up and dispersed fabric of Rabaul, assessment of their effectiveness should be based on this. The relinking role of roads needs to be seen in conjunction with the other objectives of the program seen in Figure 17, to evaluate whether the program goals were supported.

As seen from Figure 17, two kinds of relocation were planned. On the one hand, rural populations had to be resettled beyond the tephra high hazard zone shown on the map in Figure 16. On the other hand, Rabaul urban services, infrastructure and population had to be relocated to the Kokopo area. Some infrastructure, particularly the new airport, was relocated beyond Kokopo town boundaries. A brief assessment is given here of the effectiveness of firstly, town relocation and secondly, the rural population resettlement. A model of the spatial arrangement of the rural and urban relocation is shown in Figure 22. Success of the Gazelle Restoration Program roads are assessed within this framework.

3.2.1 Success of urban relocation

As seen from Figure 22, relocation of town facilities, infrastructure and population was in essence a transposition; picking up these parts of Rabaul and putting them down again in Kokopo. The port, its freight handling and bulk storage facilities, and vessel maintenance could not be relocated because Kokopo has no sheltered deep water for a new port. For this reason, the wharves, petroleum storage, shipping management, some warehouses, workshops and notably the CPL Toboi mill which outputs bulk copra oil, remain in Rabaul.

Sealed roads from Rabaul to Kokopo town and the new Tokua airport were constructed. For the many businesses that have chosen to relocate, the road from Kokopo to Rabaul is an acceptable compromise for losing location at the port itself. Retail businesses and the service sector rely more on location at the population centre than on location at the bulk freight point, so that their



ITRP and MTRP Phase 1. Source: GRA ITRP and MTRP itemised project expenditure spreadsheet data, recalculated.

Figure 19. Contribution by donor, Gazelle Restoration Program 1995-2008.

economic position was not greatly affected by the move. High value, low bulk industries such as the PNG Balsa mill are also little affected by location at Kokopo, because shipment of the low-bulk output by container truck along the Kokopo-Rabaul road is an acceptable cost. So far, urban development in Kokopo has been a success, with private investment continuing to grow on the back of public investment, and strong urban income opportunities in Kokopo.

The situation in Rabaul has not worked out so well. Relocation is difficult or impossible for those businesses directly tied to the port or with high-bulk products, as mentioned above. On the other hand, the costs of remaining in Rabaul for these businesses are high. A number of Rabaul businesses chose to leave East New Britain rather than relocate to Kokopo. Some remaining Rabaul businesses, particularly the CPL Toboi mill and Rabaul Shipping need port location, yet the acidic and abrasive volcanic ash falling in Rabaul corrodes their rooves and finds its way into machinery, creating high costs. They may eventually shift to Lae, because there is no other suitable port site in the Gazelle Peninsula. The traditional importance of Rabaul a shipping hub for the New Guinea Islands region, and the resulting flow of benefits to the province, has been eroded by the eruption.

While relocation has moved most people and facilities out of the high-risk eruption zone, there is still a high residual population in Rabaul and surrounding eruption zone. This population is ancillary to the remaining port activities, which provide employment and other downstream opportunities, such as retailing and fresh produce marketing. Inevitably, the port attracts people. The western end of the town has now been largely rebuilt as a consequence. In small part, the repopulation is also consequence of the ITRP objective to 'restore sections of Rabaul for port services' without a strict planning definition that would carry through the initial intention for Rabaul to become a satellite port without a residential or commercial sector. In Rabaul, urban relocation objectives were not fully realised and the overall Gazelle Restoration Program goal of relocation has been compromised. This cannot be taken as a fundamental criticism of the Gazelle Restoration Program because the inability to relocate the port itself is an intractable problem.

3.2.2 Success of rural resettlement

Actual resettlement areas and associated infrastructure were mapped in Figure 16. The logic of resettlement is shown in model form in Figure 22. Prior to the eruption, Rabaul was encircled by mainly coastal populations, living on traditional lands. Some areas such as Matupit were very close to the town, had very dense populations and relied almost exclusively on town income opportunities. In effect, these were Rabaul's peri-urban areas. The villages a little further away relied more on a mix of urban opportunity, subsistence farming and cash-cropping. Resettlement planning regarded resettlement of these peri-urban and near-urban Rabaul rural populations as quite separate from urban relocation issues. As Figure 22 hints by juxtaposing an actual and an ideal model of resettlement, this was not a good idea.

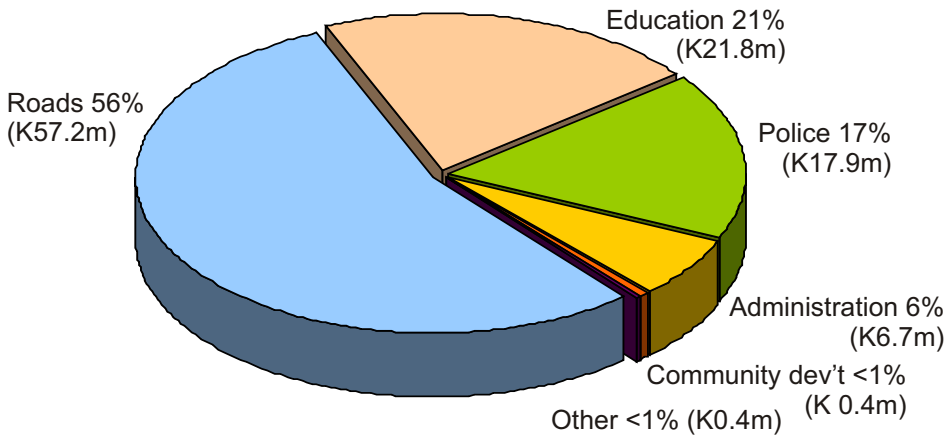


Figure 20. AusAID funding by sector, Gazelle Restoration Program 1995-2008.

The resettlement areas for the Rabaul rural populations were created on old inland plantation sites. The resettlement areas are made of household block areas arranged in a new semi-urban setting, each with roads, water, schools and clinic facilities, although without commercial facilities. They act as satellite settlements to the larger surrounding townships of Kokopo and Warangoi, although are mostly quite distant from both. Apart from the lack of commercial facilities, it seems that the idea was to recreate the dense living arrangements of Matupit and other Rabaul peri-urban areas. The resettlement areas took some years to construct, indeed the surveying, setting-out of roads and construction of facilities is still continuing slowly. In the interim, many people who camped in the initial poor facilities returned to their home lands around Rabaul. Others in the family stayed, used clan ties to move into the Kokopo peri-urban zone or bought land in the Baining lowland informal settlement belt. These large informal population movements that were not absorbed by official resettlement to the Warangoi valley have placed stress in the peri-urban zone near Kokopo, and created extra pressure on the new settlement belt.

Shortfalls in meeting the original objectives began to show up in the results of a 1998 census of the resettlement program (Table 3). Notably this shows that about half the rural populations from the eruption-affected areas had opted to settle in the resettlement areas, while another third had returned to their home village sites in the affected areas, which was not part of the plan. The remainder, about 10%, had either resettled informally or were, at that time, still in the temporary care centres.

More recent figures are not available, but informants described the current situation. More people have departed the resettlement areas, since the subdivision plots were too small for many families. These people either have gone back to the eruption area home villages, or found ways to relocate to clan areas in the Kokopo peri-urban area or gone on to informal settlement in the new settlement belt as noted above. This implies that the majority of the population for which the resettlements were intended, did not end up in the new areas. Now, well over a decade later, the haphazard patterns of return settlement and informal settlement that occurred concurrently with official settlement programs have gained permanency and increasing acceptance as a *fait accompli*.

In hindsight, the dense living arrangements of near-Rabaul settlements such as Matupit were not a good model for the far-flung inland resettlement areas, because they are not in similar town-side locations, with the same town-side income generating opportunities. The inland resettlement areas needed more space for family cash cropping so people could adapt to their new location in the economic landscape. Some resettlement opportunities would ideally have been made available close to Kokopo, where replication of Matupit-like dense peri-urban settlement arrangement could have been more successful. Figure 22 shows the ideal scenario, in which it is presumed that town-side land would be more difficult to acquire, so some low-density inland resettlement would also be necessary. In the event, many people made these adjustments themselves, so that the bulk of resettlement has ultimately been unofficial, unplanned and unfacilitated.[12]

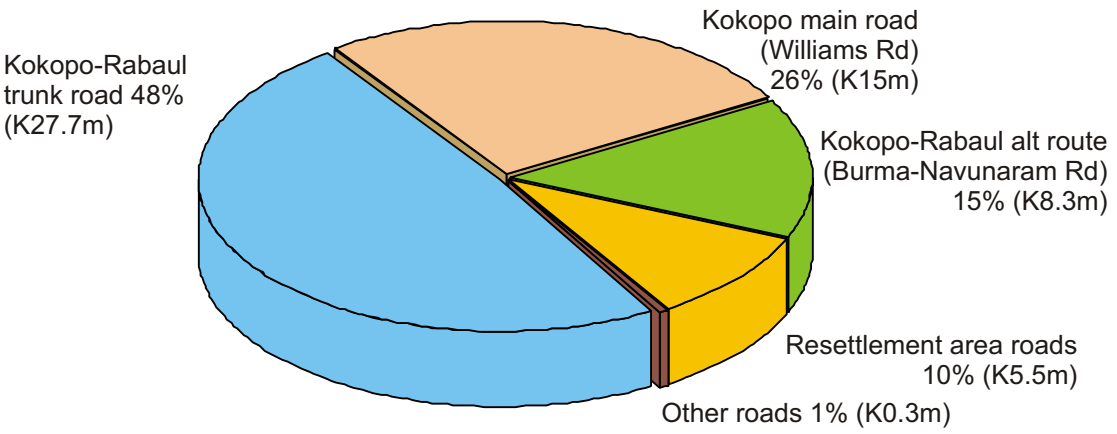


Figure 21. AusAID roads expenditure, Gazelle Restoration Program 1995-2008.

3.2.3 Effectiveness of the Gazelle Restoration Program roads

The low success of rural resettlement was not made worse by failings in road infrastructure. The access roads from Kokopo to the resettlement areas, seen in Figure 16, were adequately constructed sealed upgrades of existing roads. They were recognised early on in the restoration planning as a necessary part of the wider restoration effort. They do not present diseconomies as they might if not upgraded at all, or if they had badly degraded since. The main difficulty is the distance to town, which means that transport costs are too high for many people to regularly commute to town for work or market, as they did before 1994 when they lived near Rabaul. This has led many people to adapt to new economic activities for which the settlement areas themselves were unsuited, as noted above.

A question arises as to the sustainability of the upgraded rural roads. This is whether they can be maintained using recurrent maintenance budgets, or whether new budget demands have been created by the upgrades. No new roads have been created with the exception of short road segments within the resettlement areas themselves. However the upgrades have converted sections of lower-maintenance narrow gravel road to sealed or wider gravel road with higher traffic flows, resulting in higher maintenance costs. These ongoing extra costs would have been more justified had the resettlement schemes been more successfully implemented. The volcanoes around Rabaul had been officially recognised as a hazard since at least 1984. With such foresight, devising a socio-economic architecture for resettlement and ensuing land acquisition could have been prepared well ahead of disaster.

AusAID had funded a police facility and school at Baliora, in anticipation of township development there under the restoration plan. The township is sited on state land, in a populated rural area 11km by road from Kokopo. It was subdivided and streets were made, but the township has not materialised. A number of clans have disputed ownership and the area has reverted to scrubland over the ten years that the dispute has gone on. The street construction there has been wasted money, but the barracks and school are both in full use, despite lack of associated township.

At the macro-level, roads have been a main component of Gazelle Restoration Program spending. The program's public investment levels were unavoidable, but nevertheless have driven a 15-year construction boom that, as public investment is ramped down, risks an employment downturn. Focus on Gazelle reconstruction has also left the rest of the province neglected for over a decade, with poverty in those areas now severe.

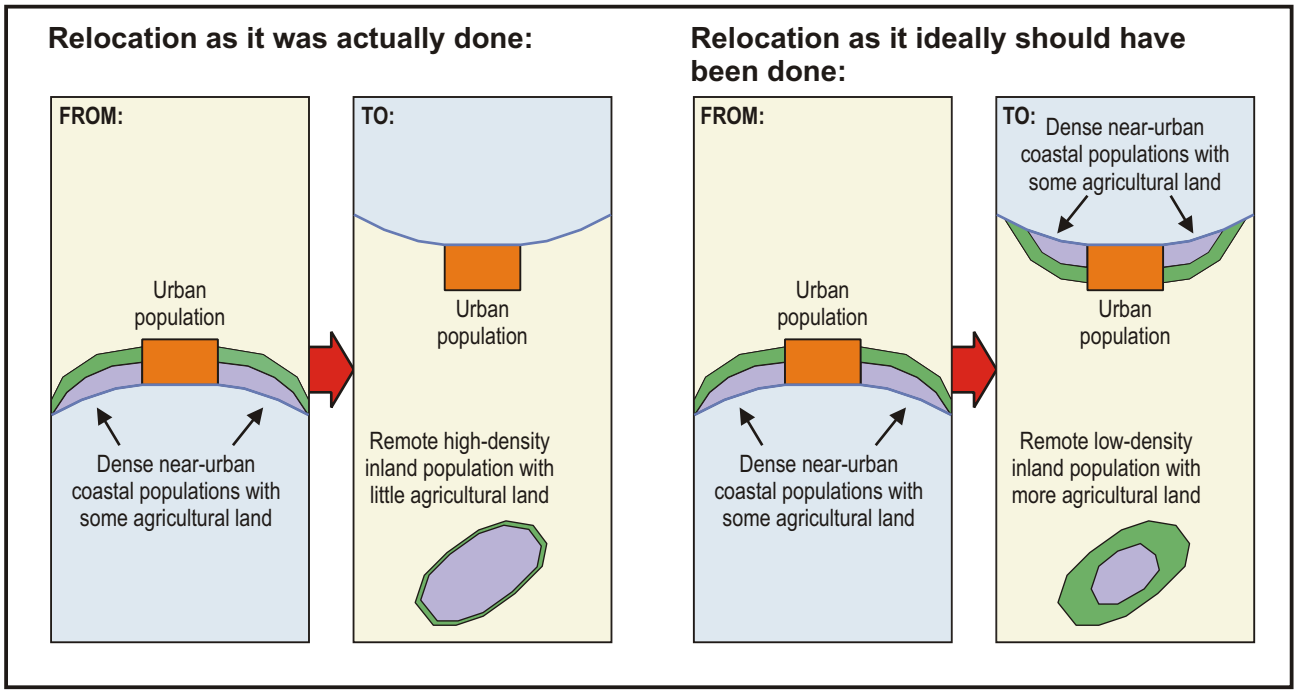


Figure 22. Models of actual and ideal relocation of Rabaul's urban and hinterland population.

Table 3. Census of formal resettlement area populations, 1998.

Settlement site	Total population intended at site	Residing at resettlement site	Returned to hazard area	Residing in care centres or informal settlements
Gelagela	5722	4397	1060	265
Clifton	6074	2067	3542	465
Sigute	4221	2383	1439	399
Warena	1253	295	275	683
Total	17270	9142	6316	1812

Source: Baseline Survey of Resettlements Preliminary report. July 1998. Prepared by Beddie Jubilee and Karolus Walagat. Gazelle Restoration Authority. Photocopied electronic document, 23p.

3.3 Kokopo-Rabaul trunk road

The largest Gazelle restoration road project funded by AusAID was the dual-lane Kokopo-Rabaul road including drainage and bridge work, costing about K28 million (Table 2). It was noted earlier that the Gazelle road network has a distinctive tight clustering of feeder roads leading onto a very short trunk road to the port. The Kokopo-Rabaul road is this trunk road, and as such is structurally central to the many export crop market chains running through the northeast Gazelle economic landscape. Prior to the eruption then, the Kokopo-Rabaul road already had the role of the trunk route from the main export-crop producing areas to the port. Kokopo too had its origins in colonial times. The reconstruction of the Kokopo-Rabaul road did not rearrange the existing road network, but urban relocation to Kokopo has had the effect of shifting the centre of gravity of the network away from Rabaul.

The main impetus for the large expenditure on the road was to augment its original market chain role by providing efficient high-volume low-cost freight linkage between the old port and the new township as part of the restoration program. The intention was to reduce, as much as possible, the transport costs between the two centres that all businesses faced as a result of relocation. The road was designed to carry all heavy freight transport, such as trucks carrying shipping containers, between Rabaul port and relocated businesses in Kokopo Town. Some of this freight is port-bound flows of processed goods (e.g. milled balsa) for export, and a large part is town-bound flows of imported consumption goods (e.g. rice and clothing). In the reconstruction, the old pre-eruption road was widened and strengthened, and its sealed surface was renewed.

As noted earlier, the road will also function as an escape route from Rabaul when Tavurvur erupts again. There is no doubt that the Kokopo-Rabaul road is the most vital link in the northeast Gazelle road network. Impact of the road can be considered also by the counterfactual: if there were no road linking Rabaul port to the new provincial centre at Kokopo, and to the agricultural areas beyond, the ENB economy would slow sharply.

There are problems with the road. Complaint centres on the amount of erosion sediment that washes onto the road. This appears as deep drifts over some sections of the road, reducing road quality to an ungraded unsealed surface unsuited to heavy vehicle transport. These degraded sections are mapped in Figure 23. Some degraded sections cover the road only partially, while others are full or almost full coverage of the road surface. The worst sections are the extended Malaguna and Vulcan sections, and shorter degraded sections at Ranguna stream crossing and at Raluana. The constant siltation poses both maintenance and engineering challenges that were not originally anticipated. Drainage structures are not adequate for the sediment loads now occurring.

About 1.4 km of road in the Malaguna section is more than 80% covered in silt. This is caused by recent ashfall sediments washing down the slope in the caldera wall catchment area, especially those parts that are under the ash plume that continues to erupt from Tavurvur. In the AusAID-funded section, 630m at Ialakua in the Raluan section, and 440m where the road crosses the Ranguna watercourse are 100% covered by silt. Here at Ranguna, a concrete bridge built to span what was the stream bed is now buried in sediment. The culvert filled up, and silt then built up over the road to create a natural floodway. This stream is the outlet of a large catchment area extending back to Toma, Vunadidir and Navunaram, taking in much of the intensive peri-urban settlement stimulated by the expansion of Kokopo. Gully erosion occurring in these headwater

areas. Smallholder plantations, even houses, are falling into deep sheer-walled ravines that are extending quite rapidly (about 20m each year near Vunadidir) up even the smallest tributaries. The effect has been attributed to clearing and house-building that concentrates stormwater runoff, which then flash-floods down the rivulets, carrying the soft ashy ground with it. This is ending up in a large delta that is actively prograding in Blanche Bay at the Ranguna stream mouth. The road crosses the floodway where sediment is depositing on this new delta. To slow the erosion, residents upstream are being instructed in an array of flood-retaining works, from groundcovers and slope terracing to water tanks for roof stormwater retention.[13] This will all help, but population is set to expand in the catchment, counteracting these efforts. It is likely that the erosion will continue.

The road sedimentation can be remediated by regular ongoing maintenance, or by re-engineering, and in some cases by the above-mentioned improvements to land management in the catchments.

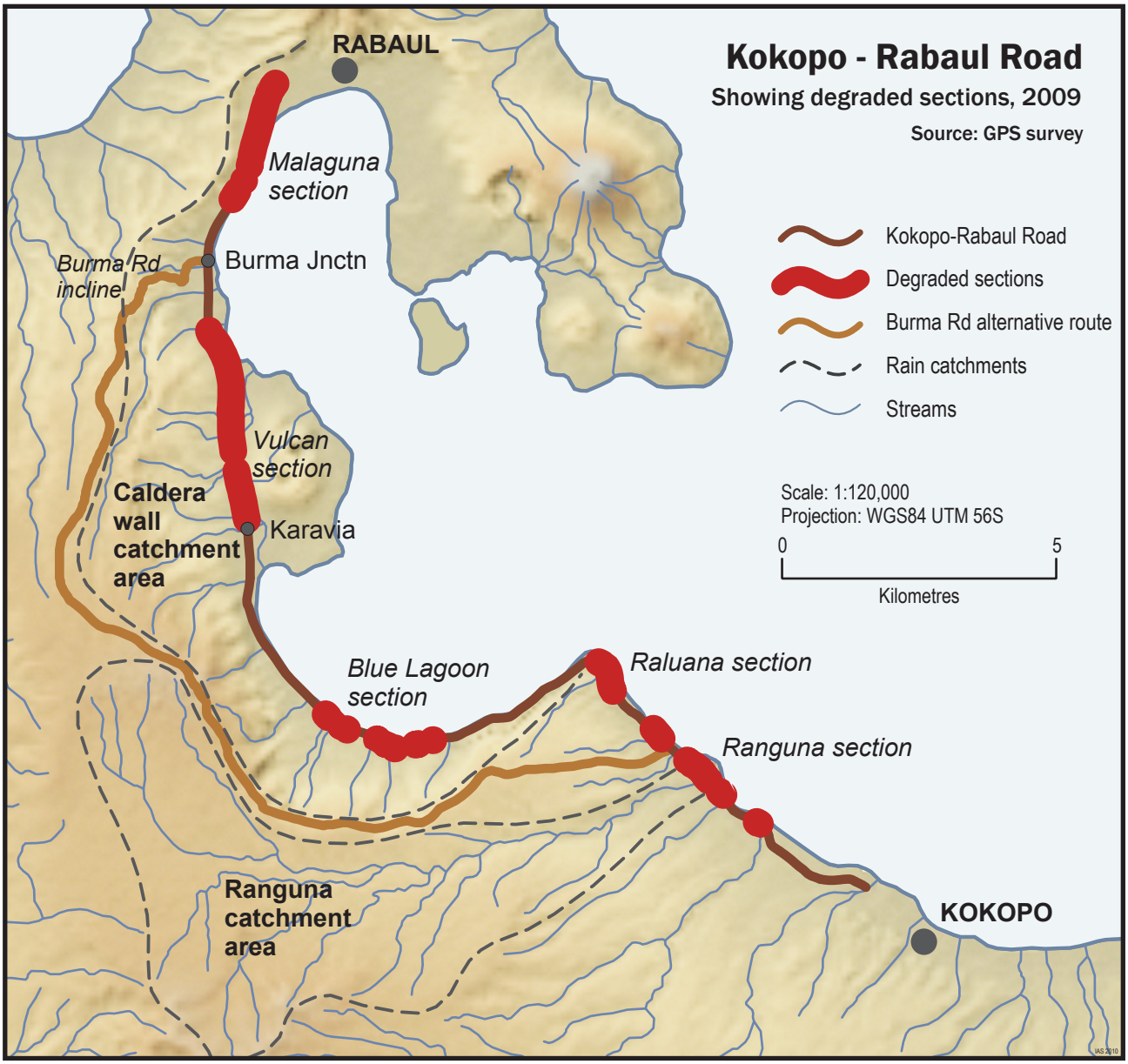


Figure 23. Kokopo-Rabaul main road, showing degraded sections. AusAID funded the stretch from Kokopo to Karavia, and the World Bank funded the stretch from Karavia to Rabaul. Heavy siltation has occured on the Ranguna section due to gully erosion in the Ranguna catchment. Siltation on the Malaguna section is also severe, caused by sheet erosion of recent ashfall. The Vulcan section was never sealed. The Burma Road alternative route runs along the top of the caldera wall so is not affected by siltation.

Maintenance under the GRA budget stopped in 2008, after which it became a GoPNG budget responsibility, and the silt is said to have been building up since it is no longer cleared away. For maintenance and for re-engineering options, budgetary constraints limit what can be done.

The 3.6 km unsealed Vulcan section remains by far the worst section of road, but for another reason. The road here had been buried by deep ashfall from the 1994 Vulcan eruption. At the time of the trunk road upgrading, engineers noted that ground movement was still occurring and also the deep ashfall layer was considered too soft for a sealed road. However, a 380m sealed 'test strip' made midway along the section is holding up well. Initially too there was local opposition to the road realignment in this section, although this has been solved.[14] This section (Burma Junction to Karavia) was originally to be reconstructed with World Bank funds, but this has not occurred.[15] A design was made in 2006 to seal the Vulcan section, estimated to cost K10M including drainage. No commitment has been made for funding to complete this last section as yet.

The open question then is whether the road is 'good enough', or whether its current condition is strongly impacting on the economy. Road freight is not yet deterred by the deteriorating condition of the road, although traffic is slowed down over the silted sections, and truck owners claim that maintenance costs are raised due to the heavily corrugated, hummocky and fissured surface. Nearby settlements are covered in clouds of road dust. All stakeholders agree that removing the silt and preventing its re-deposition would be desirable.

As time goes on and silt builds up, the road appears more like a bad unsealed road, negating the large initial expenditure on it. In future, unless a threshold of 'tolerable degradation' is established beyond which remediation occurs, the linkage which the road provides will become very inefficient and costly for relocated businesses reliant on it. This is more likely to occur during wet weather. Smaller vehicles, the type used for passenger traffic and outward-bound bulk crops, can detour up over the 5km longer Burma-Navunaram alternative route at these times, but the large container trucks, mainly used to transport inward-bound consumption goods, cannot safely negotiate the winding Burma Rd escarpment incline; in addition their heavy axle loadings would soon destroy the lightly built road surface of the alternative route. As road conditions worsen, dysfunctional linkage to Kokopo will tend to stimulate alternative development in Rabaul.

At this stage it should still be expected that remedial maintenance by the road's owner, GoPNG, can keep the link open. Capacity for this could be supported through national transport sector support programming. The road was built in 2000 to a design life of 20 years, so reconstruction work should be considered for 2020. In view of the road's importance, reconstruction of the Vulcan section should be a priority, but engineered to ensure minimal mudflow silt build-up.

3.4 Provincial Performance Improvement Initiative (PPII) roads

Other development initiatives have been implemented in East New Britain since the eruption. One of these is the PPII, a program which provides a fiscal incentive for PNG provincial governments to improve their public administration and service delivery. PPII is supported by the AusAID Sub-National Strategy (SNS) to improve the performance of provincial governments in PNG.

In East New Britain, three existing roads have been partially rehabilitated since August 2005 using PPII funds. From 2005 to 2009, K1M a year was provided by PPII to ENBPA. The provincial government was at liberty to use these funds in a variety of budget areas. From 2005 to 2008 the province mostly chose to fund road projects. Allocation of the PPII funds to roads totalled K2.3M from 2005-2007. The road works funded during these years are listed in Table 4. In the same period, total ENBPA roads budgeting totalled K13.3M, so that the PPII contributed 17% of road funds in that period. The emphasis placed on roads in use of the PPII funds demonstrates the recognition by the government of the role roads have historically played in ENB for agricultural economic growth,[16] and was seen as an opportunity to revive the role of government in roads provision that existed prior to the OLPLLG ('organic law'). Road sections rehabilitated under the PPII were toward the periphery of the existing Gazelle road network: the South Coast road, Utmei road (leading to Lassul Bay), and the Burit-Malasaet road.

3.4.1 PPII roads as part of wider plans

Concentration on roads towards the periphery of the current road network is part of the ENBPA's wider plan to upgrade roads that will channel population out of the northeast Gazelle and develop new remote hinterland areas focussed on growth centres. This plan is discussed in greater depth under the section on Provincial development planning below. As the plan needs some years yet to be realised, consideration here with regard to the PPII roads can only be on the plan's merits.

There are a number of difficulties with the plan. The planned growth areas outside the northeast Gazelle are much poorer for subsistence cropping than those within the northeast Gazelle area, so fewer people will want to live there. Although cocoa will probably grow satisfactorily in the proposed growth areas allowing settlers to buy in subsistence food (e.g. rice), Cocoa Pod Borer has thrown this cash source into question. Landowners in the Pomio and Baining areas are unwilling to host new settlers from the northeast Gazelle, because they worry about crime and cultural domination. Long roads into the growth areas will not be well maintained since the province struggles to maintain its current road assets (this is covered in detail below).

Instead of a trend to move out of the northeast Gazelle altogether, current informal settlement patterns demonstrate that demand for land is along the southern fringes of the northeast Gazelle where fertility is still good for subsistence and cash crops and town services are nearby: but these areas are not part of the plan. Women's local produce marketing was shown earlier to be very sensitive to distance from town; the plan to move people into remote areas will disadvantage women. Conversely, a policy to optimise the current unregulated informal settlement areas could potentially assist women with market access. Resettlement of people according to the growth centre strategy is happening to some extent where roads have been upgraded with PPII funds, but only where the roads pass through the new settlement belt.

3.4.2 Local impact of the PPII road sections

Table 4 shows that after initial work of patching the worst sections of the long and peripheral Malasaet and South Coast roads, funds were spent on quite short sections of road. The initial remedial work (in 2005) affected about 10% of provincial roads, allowing vehicular access to remote villages for the first time in years, although the roads remained rough. The later two years of funding focussed on higher quality upgrade to shorter sections of road, which affected only 1% of provincial roads. These later 'quality' works used 58% of the PPII funds spent on roads. Impact has to be seen within those overall proportions.

The impact of the early remedial work was cost effective and made a positive social and economic impact. Remedial work on the Malasaet road provided market-chain access for the disadvantaged and remote population in the Malasaet area, helping with transport of spices being grown there. Early work on the South Coast Road reconnected communities at Putput and Induna to the markets after some years of very difficult road conditions. In part, one impact has been development of organic oil manufacture at Induna. Unfortunately the access to Malasaet soon deteriorated again, because the maintenance was a one-off.

The impact of later road work has not been as cost effective with regard to social and economic benefits. Work on the Butam section of the South Coast Road coincided with an influx of new informal settlers there. At the time a self-proclaimed landowner (in the midst of legal challenge by other land title claimants) was offering smallholder blocks to people desperate for land. They would probably have settled there regardless of road condition. While the road upgrade improves their access to town, because it has facilitated PMV access, a rougher, cheaper, road upgrade would have enabled most of this access. The sealed Utmei road section is a very short section of road upgrade that was still being constructed in early 2009. It will facilitate access to Utmei High School, but the high quality of the upgrade is not critical for access to the school.

Given the overall state of ENB roads (discussed below), the PPII experience shows that it is better to use funds on low-cost remedial work that provides basic access along longer sections of road. The logic of the later spending on short, high-quality sections seems to have been that these

Table 4. PPII program road improvements 2005-2007.

Road	Activity	Approx length	Year	Amount allocated (PGK)
Malasaet Rd	Patching	30km	2005	463,743
South Coast Rd	Patching	30km	2005	496,257
Utmei Rd	Sealing, section I	670m	2006	291,746
Burit-Malasaet Rd	Coronous, section I	1400m	2006	227,972
South Coast Rd	Coronous, section I	950m	2006	321,355
Utmei Rd	Sealing, section II	1890m	2007	145,311
Burit-Malasaet Rd	Coronous, section II	960m	2007	144,905
South Coast Rd	Coronous, section II	1000m	2007	209,784
Total				2,301,073

Source: Briefing document to ENBPA executive, c.April 2008; GPS road survey.

sections could be extended upon incrementally once more funds are available. Under conditions of chronic funding shortage, which is the reality for ENB, this is a less effective strategy than extensive low-cost remedial work providing immediate benefit to communities that suffer from poor market access. This is both because the initial expenditure is less cost-effective, and because there is a strong risk that the expensive upgrade will be negated by deterioration due to absence of maintenance budgeting.

3.5 Lessons for post-disaster and sectoral-support road programs

Two kinds of road program have been assessed here. These are roads that were reconstructed to take on new roles as part of post-disaster restoration, and roads rehabilitated as part of donor sectoral support, in this case the PPII program.

The study has clarified the role of roads in post-disaster reconstruction: they are the major way by which to restore economic and social linkages that are disrupted when post-disaster relocation divides urban fabrics and disperses rural populations during resettlement.

The Kokopo-Rabaul trunk road assumed the new role of link road between port facilities that have stayed behind and urban infrastructure and services that were relocated. While the trunk road always had provided the main conduit for outward-bound freight as part of the export crop market chain, in its new role the road now also carries import freight to the shops, offices and industries located in the new urban centre. Without this feed of supplies the new urban centre could not have been split away from the port.

Rural resettlement was not so well implemented. Insufficient attention to locational economics in terms of population density, distance from urban centres, and land required for subsistence agriculture, ultimately saw most of the resettlement areas fail to hold their intended population. The roads that were built to link the settlement sites to town are underutilised in their intended function, simply because many people abandoned the sites. This underscores the sensitivity of resettlement to overall social and economic architecture, and the inability of infrastructure provision like roads or the other infrastructure provided, to induce people to resettle if the overall architecture does not suit people's needs.

The study has in a minor way shown the lesson of two approaches to roads funding under the PPII program. Early expenditure by the province was for remediation of largely impassable feeder roads with rough patching of the worst sections. Long stretches of road to remote communities were opened in this way, with immediate benefits to these communities in terms of market access. The program then moved away from this remedial approach, to spending large sums of money on short, high-quality road sections that would be added to year-by-year. This approach had no more economic impact than rudimentary dry-weather access. Spending on the short sections did however divert maintenance away from the earlier remediated sections, so their access was soon impeded. More benefit was obtained with low-cost solutions; beyond which extra expenditure added very little extra benefit. Spreading the funding thinly over the road network is a better way to reach the goal of providing market and services access, especially to remote communities.

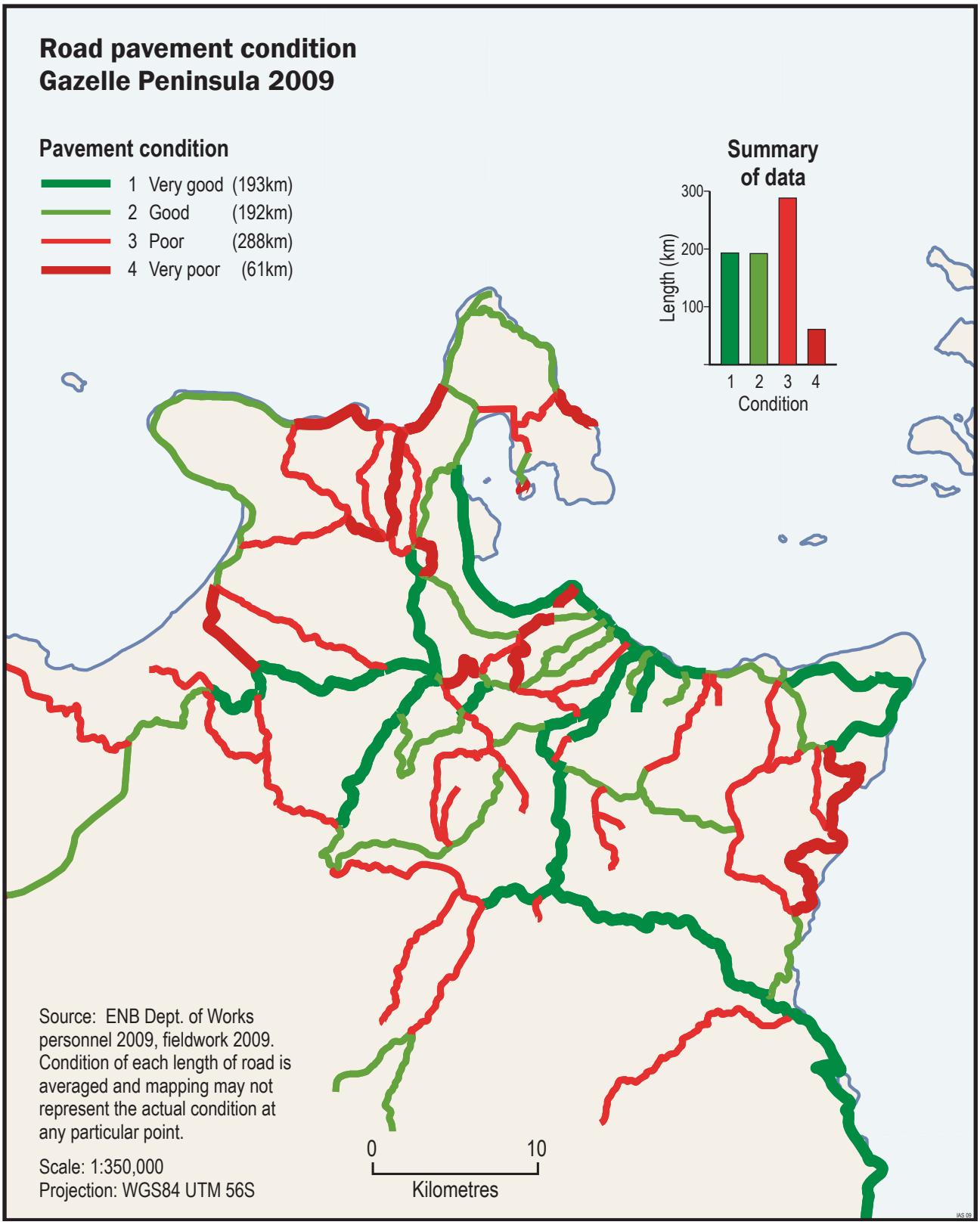


Figure 24. Road pavement condition in 2009. Pavement condition of the northeast Gazelle network is better (shown in green) where post-eruption restoration funding has been used for road rehabilitation.The summary graph shows that 'poor' road surfaces are the most common condition, but few roads are in 'very poor' condition.

4. Roads in current Provincial development planning

Roads are well understood by provincial politicians and administrators to have been a vital part of the historical development of the Gazelle Peninsula, and are seen as a tangible sign of the strong level of development attained in the area. Consequently roads are understood as a principal component to future provincial development.

4.1 Road condition and provincial budget

Despite the importance put by provincial leaders on roads as a factor in development, there is a common perception among them that the road network is falling into disrepair due to insufficient maintenance funds. ENB provincial leaders attribute the state of the roads to changes in revenue-raising legislation in 1995 under the Organic Law on Provincial and Local Level Government. This provides for sales tax to be collected by the National Government and then redistributed among all of PNG's provinces, in contrast to the previous situation where sales tax was collected by each province and was all available for the province's own expenditure. ENB provincial leaders say the changes led to a drop in funds available for roads. The challenge for the province now is to define road expenditure priorities more sharply.

Roads in the province are built and maintained under any of five levels of government: national, provincial, district, LLG or ward. Road network condition as assessed here concerns only the national and provincial roads, as baseline data is only available for these. The present study built a new GIS road inventory for the northeast Gazelle, based on a similar inventory made in 1991.[17] This baseline analysis allows some evaluation of the provincial capacity to maintain current and proposed future road assets. A very few provincial roads existing in 2009 did not appear in the 1991 baseline data, so were not included in the analysis.

The inventory mapping conducted by the present study in 2009 has counted a total of 734km of provincial and national roads in the northeast Gazelle network, of which 605km are provincial roads and 129km are national roads (82% and 18% respectively). Figure 24 maps the roads by their condition in mid-2009, and Figure 25 maps the roads by their change in condition since 1990. In addition, this data is summarised in Table 5 and Table 6. The data shows an overall deterioration in the road pavement condition since 1990, with almost half the roads now in either marginal or poor condition (see Appendix 12 for detail of the criteria used). In 1990, just under 10% of the roads were in marginal or poor condition. The worst affected roads are the provincial roads. This quantitative analysis backs up strongly the observation by key stakeholders of deteriorating provincial capacity for road maintenance, and lends weight to their claim that post-1995 budgetary constraints have had a strong impact.

The difficulties faced by the province in maintaining its current road assets calls into question its capacity to maintain future long-distance roads, if they are built. Such roads are proposed as part of the growth centre strategy discussed below. To examine this fiscal capacity further, provincial roads budgeting in relation to total budget was traced from provincial budgets (Table 7). Some of the planned 'growth' roads, particularly the proposed New Britain Highway passing through Open Bay, would be national. National road expenditure in East New Britain could not be traced through the published Treasury budget material, and assessing national government fiscal capacity to maintain such a road was not possible in this study. However, provincial stakeholders held pessimistic opinions in this regard.

Table 5. Northeast Gazelle roads pavement condition, 2009.

	Length (km) by Condition				Total length (km)
	Grade 1 (very good)	Grade 2 (fair)	Grade 3 (marginal)	Grade 4 (poor)	
National roads	77	35	17	0	129
Provincial roads	116	157	271	61	605
Total	**193**	**192**	**288**	**61**	**734**

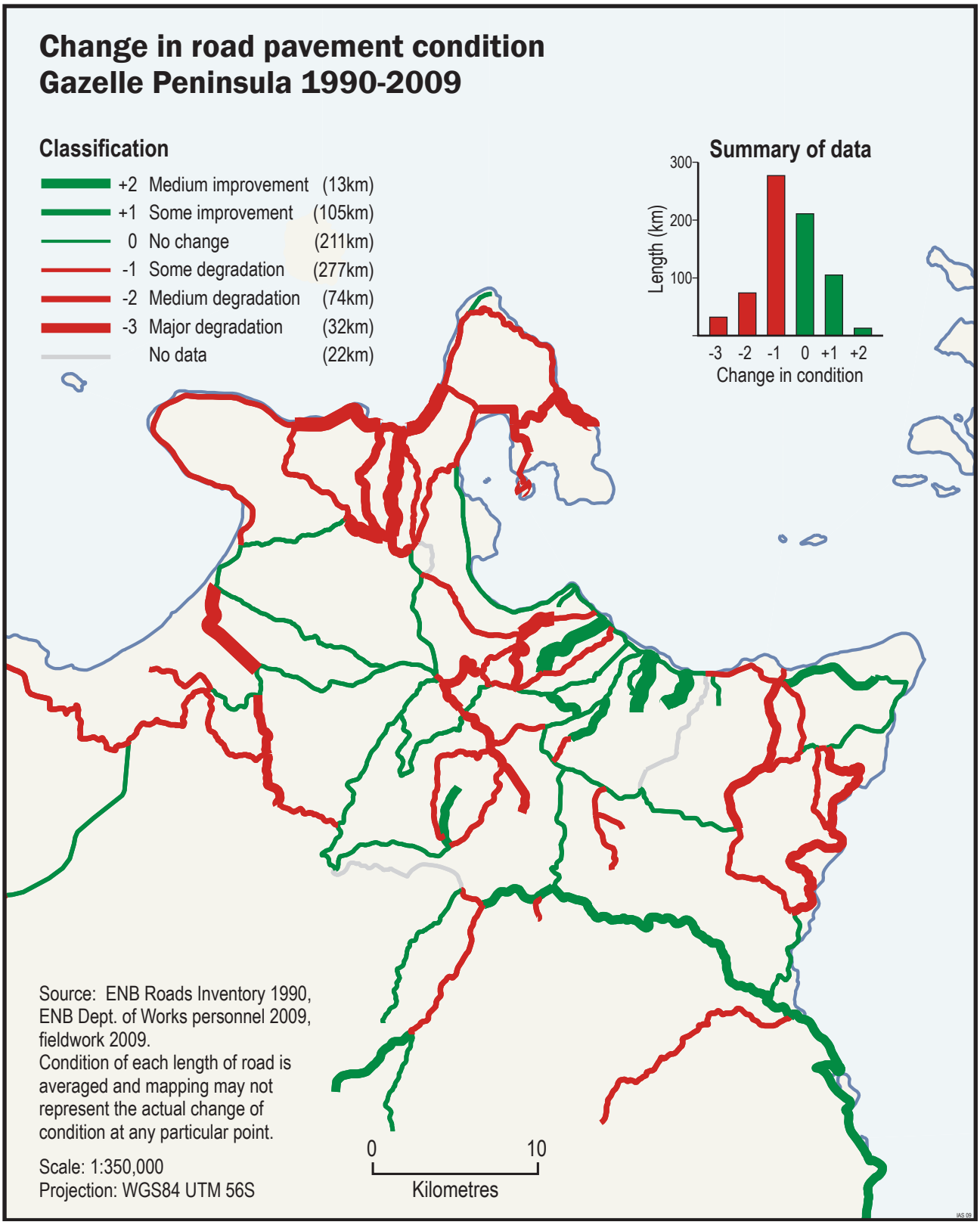


Figure 25. Change in road pavement condition, 1990-2009. Despite the input of funds for road rehabilitation as part of post-eruption restoration programs, and of PPII funding as part of AusAID's support for the Sub-National Strategy, many roads in the northeast Gazelle network are in worse condition now than they were in 1990. Others have improved, often with funds just mentioned. The ENB provincial government is already beyond its budget capacity to properly maintain the existing road network, let alone new roads.

Table 6. Northeast Gazelle roads change in condition, 1990-2009.

	Length (km) by Change in condition					
	+2 notable improve-ment	+1 some improve-ment	0 no change	-1 some deterior-ation	-2 notable deterior-ation	-3 strong deterior-ation
National Roads	0	5	72	45	8	0
Provincial Roads	13	100	139	232	67	32
Total	**13**	**105**	**211**	**277**	**74**	**32**

no data: 22km

Table 7 summarises the ENB provincial budget for roadworks from 2004 to 2008. It was derived from the roadworks-related items identified in the provincial budgets (Appendix 13). The summary data shows that proposed provincial expenditure on roadworks over the five years prior to 2009 averaged at about K4.9M annually, or about 6% of the average total annual budget. This amount is about two-thirds of that needed if all roads received an average K12,000 per km per year for maintenance. It is clear from the general decline in road pavement condition that this budget allocation is insufficient, as the ENBPA is already aware.

Analysing road network characteristics may help to prioritise road maintenance expenditure. Over decades the network has become tightly clustered and cross-linked. It may be possible to prune this back by prioritising, for example, roads that extend radially from the trunk road while demoting the cross-linked roads to dry-weather-only. GIS-based mathematical network modelling of agricultural potential, freight volumes and transport costs, linked to road maintenance costing and improved inventory management to seek optimal productivity would provide a rational basis for prioritisation. This would need to plan ahead for new agricultural patterns in response to Cocoa Pod Borer and ensuing agricultural diversification strategies. Agricultural changes are likely to require some redefinition of the road network.

4.2 ENB Growth Centre Strategy and roads

At present ENB is experiencing a major transient effect from the economic boom created by the post-eruption restoration. This has been a major economic dynamic in ENB, but is drawing to a close, at about the same time that Cocoa Pod Borer is taking hold. There is a strong risk of declining incomes and increased poverty. Planning in ENB is constrained by the uncertain future of Rabaul and the ongoing eruption. Lack of good alternative port facilities creates a tension between the need to abandon the volcanic hazard area and the need to develop the port. These overall considerations are partly addressed by current provincial planning, although this is oriented mainly toward decentralising the rural economy. Roads development as it appears in recent ENB development planning is first explained and then discussed.

4.2.1 Long-distance roads in recent ENB development planning

The ENB Gazelle Peninsula Regional Plan, commonly called the ‘growth centre strategy’, was produced as part of the MTRP in 2003.[18] A growth centre strategy was first developed for ENB in 1986, after a 1984 volcanic hazard assessment.[19] A common theme of the 1986 and 2003 strategies was to decentralise economic and government activity away from the hazard area of Rabaul. In 2003 another key aspect of the plan was to transfer population from the crowded North-east Gazelle region to underpopulated areas of the province. A third objective voiced by officials is to connect by road the provincial capitals of East and West New Britain, a vision modelled on the PNG Highlands Highway.[20]

The growth centre strategy of 2003 proposed a hierarchy of centres and road links between them. The map in Figure 26 shows the proposed centres and link roads. Two of the link roads, the Gaulim to Open Bay road and the Open Bay to Wide Bay road, were proposed as growth corridors. No detailed mapping was done for the 2003 plan, but has been done here in Figure 26. It is important to emphasise that the growth centre strategy was not based on detailed agricultural planning, and was formed before Cocoa Pod Borer appeared. Figure 26 makes explicit, for the first time, the

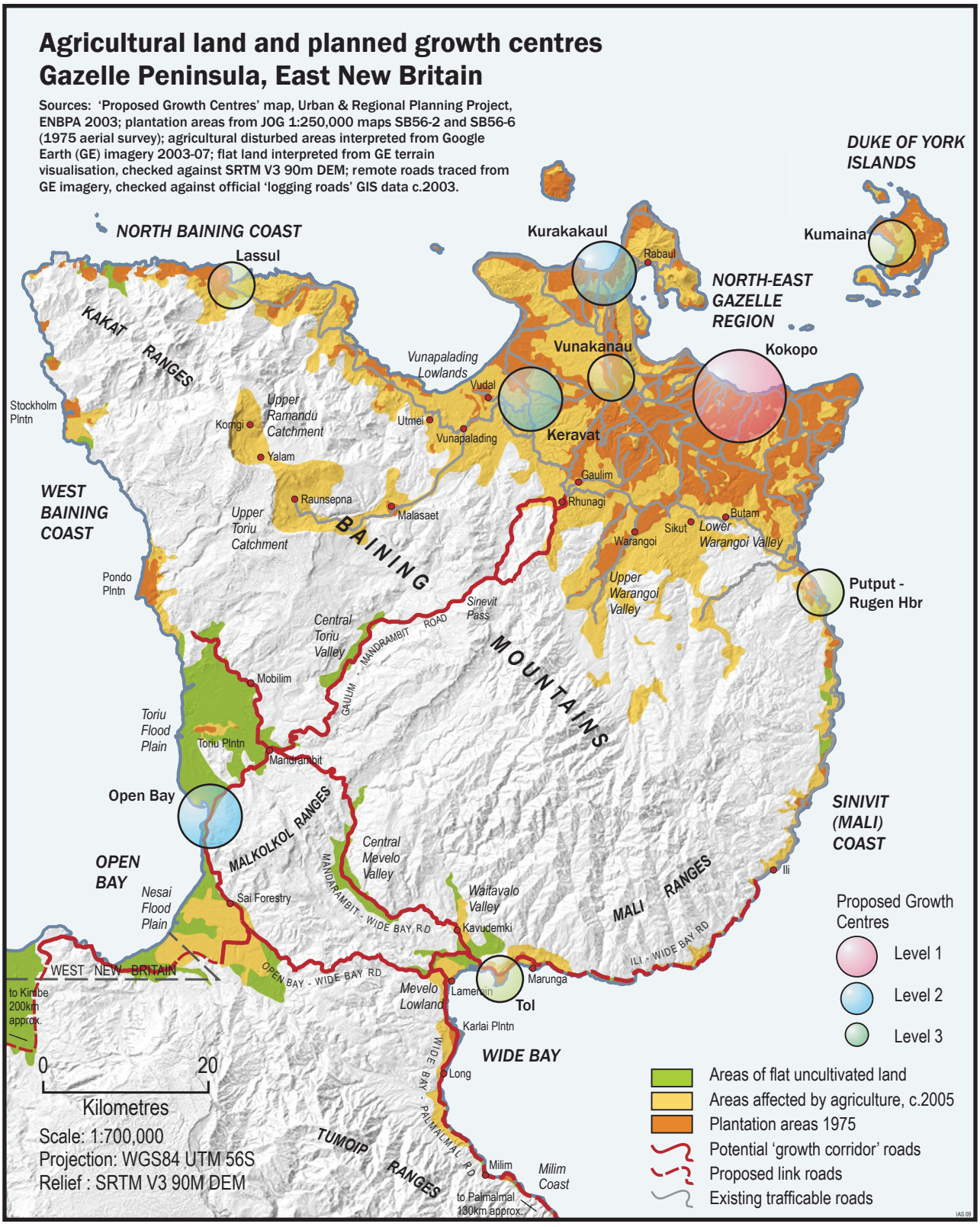


Figure 26. Agricultural land and proposed growth centres in the Gazelle Peninsula. This map shows the current extent of agriculture (yellow) in the Gazelle Peninsula, along with additional areas that are probably suitable (green). New roads that would need to be built to connect the proposed growth centres to the provincial capital of Kokopo are shown in solid red, and further proposed linkages, which are less economically viable, are shown in dashed red. Overall the growth centre strategy can be expected to lead to some new settlement, but none of the new areas has the ideal conditions found in the northeast Gazelle.

Table 7. ENB Provincial roadwork budgets, 2004-2008.

Year	Expenditure on roadworks items (K)	Total budget expenditure (K)	Roadworks as percentage of total budget (%)
2004	6,373,400	78,640,600	8.10
2005	5,180,600	69,539,500	7.45
2006	3,625,000	88,253,300	4.11
2007	4,530,000	89,220,900	5.08
2008	4,749,000	83,318,300	5.70
Average	**4,891,600**	**81,794,520**	**6.09**

routes that would be used under existing growth centre strategy and the areas of agricultural land along these routes.

The Gaulim to Open Bay road is part of the 'New Britain Highway', a long-proposed national route from Rabaul to Kimbe (West New Britain). The road exists through the populated areas from Rabaul to Gaulim, but does not extend further south except as a series of old logging tracks. The provincial government has tried for years without success to negotiate with inland Baining landowners the opening of the route. The proposed Open Bay-Wide Bay routes are also just old logging tracks for much of their distance. None of these routes are trafficable now. Nevertheless these roads are seen in the 2003 ENB Economic Development Plan as key to development.

Due to the impasse in pushing through the inland Gaulim-Open Bay road, provincial attention has turned to the coastal road to Wide Bay via Putput. From Wide Bay the road would head inland to Open Bay and then into West New Britain, sidestepping the Gaulim problem. From Wide Bay also, the coast road can continue south to Palmalmal. Figure 26 shows these extra routes. Proposed connection of Palmalmal to Kokopo by road features in the Pomio District Development Plan 2005-2010. It is favoured by the Provincial administration, and is being actively worked on by the National Parliamentary Member for Pomio, who is currently national Minister for Planning. As with the roads noted above, much of these coastal routes, particularly along the rugged coasts south of Ili, exist only as old tracks that are now completely impassable.

4.2.2 Likely benefit of the proposed ENB long distance roads

Long distance roads in ENB are attractive to provincial planners because they would connect isolated populations to the provincial capital, providing market and services access for those people. They are also attractive because they could be a conduit for settlers to spread out beyond the overpopulated northeast Gazelle. The economic benefits of the roads are less clear when considered in relation to their costs, and that brings their sustainability into question. There are also stakeholders who believe there are better alternatives.

Agricultural opportunity areas

If long distance roads are to encourage the spread of settlers out of the northeast Gazelle corner, they must be associated with land suited to agricultural opportunity. This is with regard to both subsistence crops and export crops. Figure 26 maps the distribution of agricultural land across the Gazelle Peninsula. It shows the intense agricultural use associated with the high population of the northeast Gazelle corner, hemmed in by mountains. Activity has everywhere spilled beyond the old colonial plantation areas. Some activity has followed along the coasts, but is mainly confined to the small flat areas afforded by coastal terraces (Vunapalading toward Lassul on the north coast, and along the Sinivit coast to the east) or short coastal valleys (north and west Baining coasts). The inland areas are generally mountainous and mostly unattractive for agriculture, although some traditional Baining swidden agriculture shows up in isolated mountain areas.

However, there are patches of flat uncultivated land toward the south of the Gazelle Peninsula. In the Open Bay area are the large Toriu and Nesai floodplains. Wide Bay has the moderately large Mevelo coastal lowland and nearby coastal terraces. The middle reaches of the Toriu and Mevelo

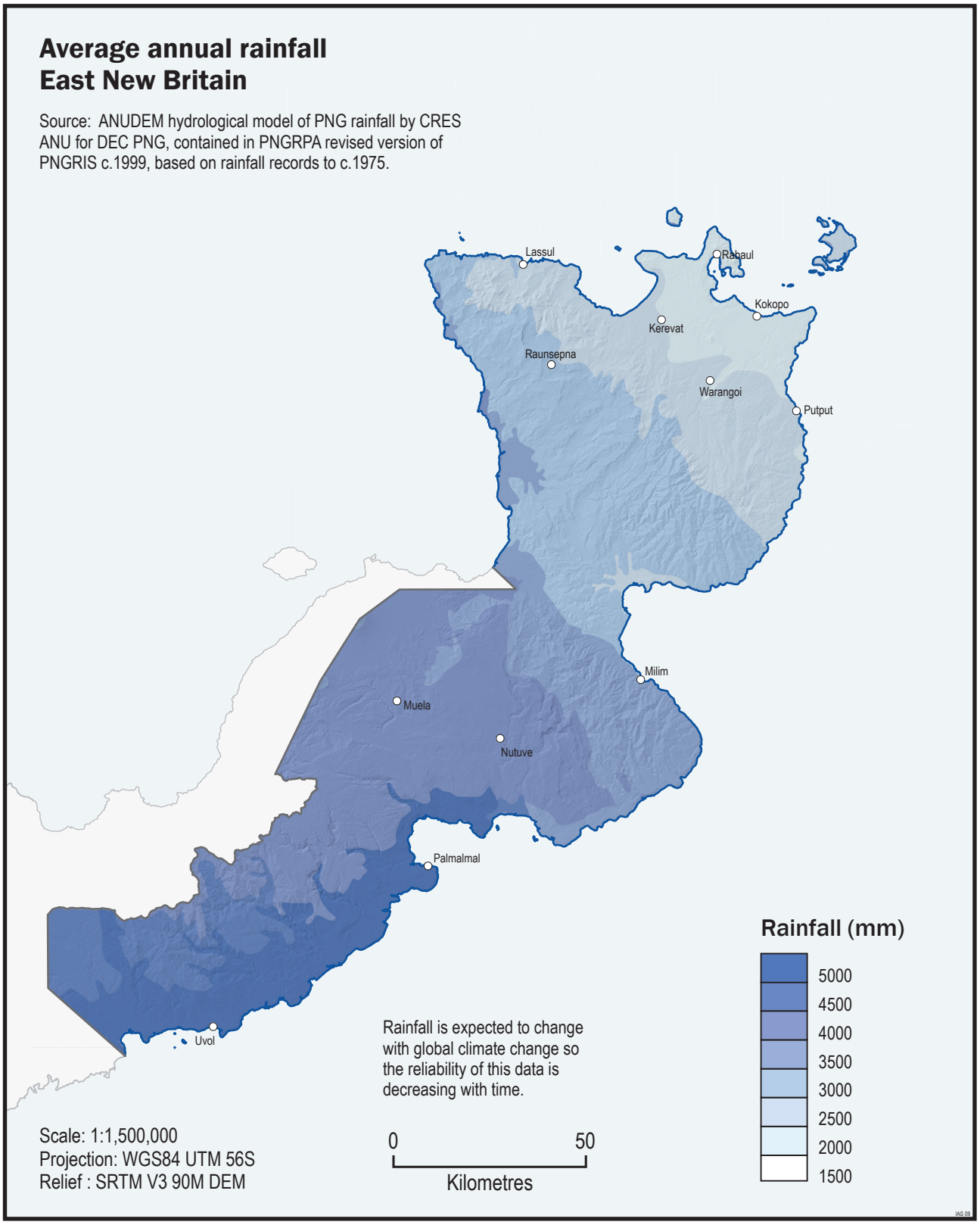


Figure 27. Average annual rainfall across East New Britain. Rainfall is a strong indicator of crop yield potential. High rainfall, as in southwest Pomio, inhibits yield of most subsistence crops and cash crops. Northeast Gazelle currently experiences ideal rainfall conditions. The records on which this map is based are now old. Rainfall data has not been methodically recorded since Independence in 1975. A likely trend in the future is that rainfall across Melanesia will increase as a result of global climate change. This will adversely affect all of East New Britain.

rivers have long flat-floored valleys. These may all be opportunity areas for agriculture, and are the areas that the growth centre strategy proposes either as centres or as growth corridors.

Agricultural potential of the opportunity areas

Because ENB is generally so mountainous, any uncultivated flat areas may seem attractive. Certainly the generally flat land of northeast Gazelle is very productive. However this is also due to other factors. Figure 27 shows rainfall distribution in ENB. Northeast Gazelle has ideal rainfall, around 2000 to 2500 mm annually. Moving south, rainfall steadily increases and becomes less suitable for agriculture. The very high rainfall in Pomio results in low crop yields there. Other important factors include soils, drainage, cloudiness, seasonal rainfall variation and slope. This study has used modelling of agricultural potential based on Hanson *et. al*. (1998) and Hanson *et. al*. (2001*a*), to assess the combined effect of all these factors.

Two crops were chosen for analysis. Sweet potato is an important subsistence crop, although there are others. Cocoa is currently the most important cash crop. Figure 28 maps the potential yield of sweet potato across ENB, as predicted by the computer model. Modelling of sweet potato potential was reconstructed from the original Hanson *et. al*. (2001*b*) modelling, as is documented in Appendix 14. The map shows northeast Gazelle is the most attractive region for sweet potato farming, and by inference, many other crops. This includes some hilly areas not yet settled south of Warangoi River and inland from the east (Sinivit) coast. The rest of the Gazelle Peninsula is moderately productive, while Pomio has low yields.

The distribution of cocoa production potential mapped in Figure 29 is taken from Hanson et. al. 1998. It predicts production based on the combination of environmental factors noted above, but does not account for cocoa pod borer which is affecting production severely now. It shows northeast Gazelle to be the best area but is also optimistic about other large areas of the Gazelle Peninsula, particularly the coasts and the proposed growth corridors along the Toriu and Mevelo rivers. This is far beyond its current planted distribution. In caution however, a cocoa potential map made by Bleeker and Freyne (1981) is much more restrained in its distribution, showing suitable areas for cocoa production mainly confined to places it is already growing.

4.2.3 Maintenance cost of long distance roads

Table 8 provides the lengths of proposed long distance roads in East New Britain. Since these roads would likely be built in stages, the actual segment lengths are shown. Costing the maintenance on a road involves a number of factors that cannot be explored here. However a reasonable costing was provided by the ENBPA Infrastructure Division, based on their experience of maintaining unsealed roads in northeast Gazelle. Grading, culvert clearing and minor repairs together cost about K6,000/km, and on an important road this needs to occur at least twice a year, bringing the minimum annual cost to K12,000/km. In difficult terrain, as found on most of the long distance routes, this cost would rise. The cost of river crossing maintenance is not calculated here but would be significant especially for the Pomio Link road.

Using the figure of K12,000/km/year, the extra cost to the East New Britain budget just for the road from Rugen Harbour to Palmalmal (290km) would be at least K3.5M per year, not allowing for the difficult terrain or including bridge maintenance. The average ENB provincial roadworks budget over the last five years has been K4.9M (Table 7). The provincial administration is aware that it is unable to maintain its current road assets, and these are deteriorating, as discussed above. Also as noted above, the sustainability of building long distance roads that could double the roadworks budgetary cost should be considered carefully. This is particularly so in the case of roads that, as in the case of the Pomio link road, will have a poor cost-benefit ratio.

4.3 Shipping options

Public roads should not be seen as the total answer to transport in ENB. Shipping has been overlooked. As noted earlier, maintenance costs on an extended south coast road to Palmalmal will be unsustainable. In general the principle should be to shift costs out of the public sector to

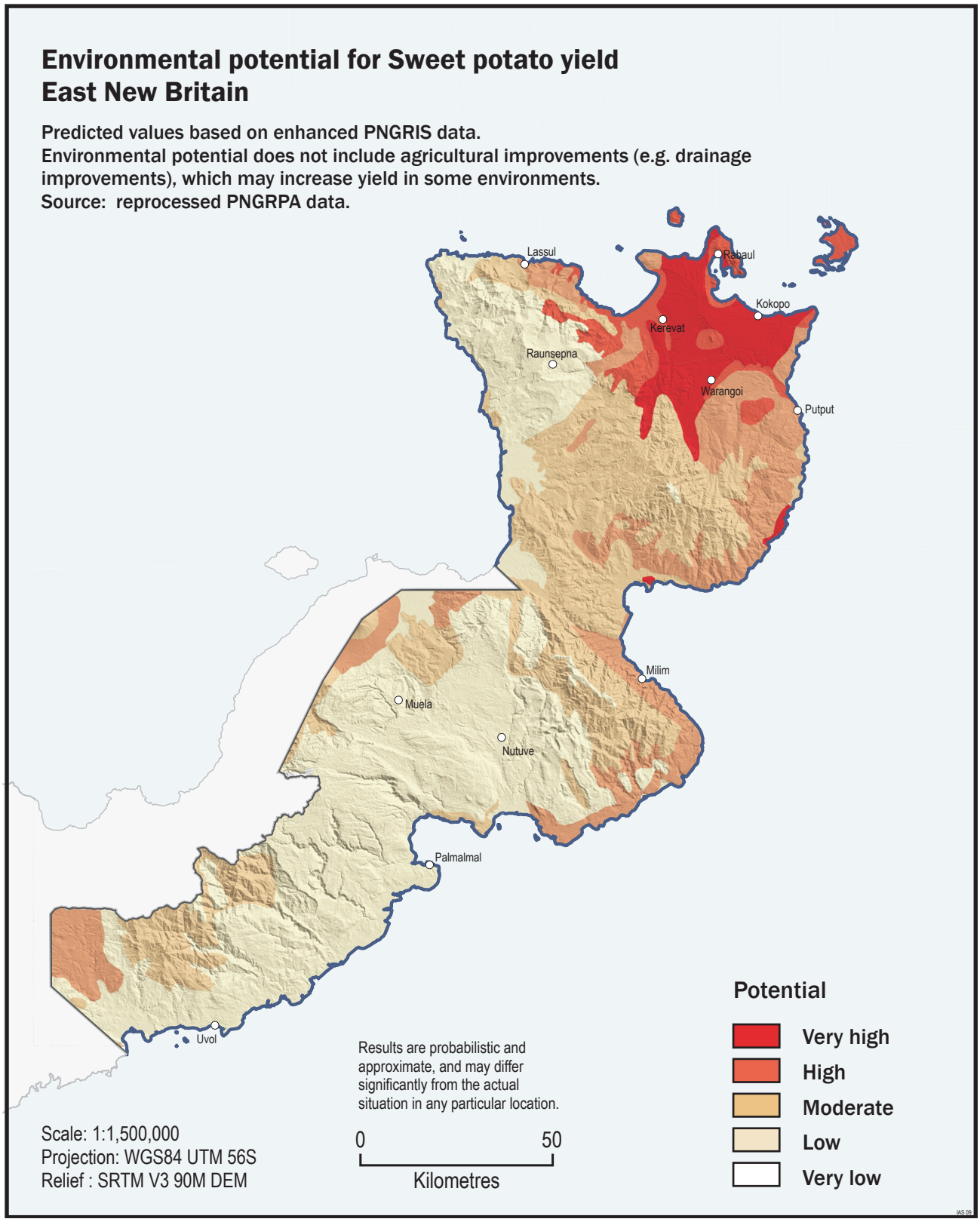


Figure 28. Sweet potato yield potential, predicted on environmental attributes. Sweet potato is a very important subsistence crop, and the ability to grow sweet potato indicates the potential for growing other subsistence crops successfully too. It grows best in the northeast Gazelle. According to the prediction, it will grow moderately well across the rest of the Gazelle Peninsula and in northeast Pomio. These are areas in which the ENB government wants to promote growth centres. However yields are likely to be less in these areas than in the northeast Gazelle, which will limit the attraction for settlers. Pomio has low potential. This map must be treated with caution as it is just a prediction.

Table 8. Lengths of proposed long-distance roads.

Road Segment	Route	Distance (km)	Responsible agency
Rhunagi - Mandarambit	New Britain Hwy	62.7	National
Mandrambit - SAI Forestry Junction	New Britain Hwy	29.4	National
Mandrambit - Wide Bay	Open Bay - Wide Bay	47.3	Provincial
SAI Forestry Jnctn - Lamerain Jnctn	Open Bay - Wide Bay	28.7	Provincial
Warangoi Mill - Rugen Harbour	South Coast Rd	29.3	Provincial
Rugen Hbr - Ili	South Coast Rd	45.0	Provincial
Ili - Lamerain	Pomio Link Rd	58.9	Provincial
Lamerain - Wawas	Pomio Link Rd	63.3	Provincial
Wawas - Pomio Town	Pomio Link Rd	98.4	Provincial
Pomio Town - Palmalmal	Pomio Link Rd	24.5	Provincial
Total length		**487.5**	

the public sector, not add costs to a public sector which cannot afford its current commitments. Government could instead consider ways to support to private sector shipping. This is sustainable, whereas cost-shifting from private sector shipping to public sector roads is not. The revenue saved can then be applied to inland roads, especially to the new settlement belt in the Baining lowlands. Appropriate support would be feeder roads to the wharves, wharf infrastructure and agricultural extension services, which in combination would increase freight flows, in turn making shipping more viable. The model here is cost-effective public investment to support private investment, rather than having public investment replace private investment.

Figure 30 shows wharf locations and Table 9 summarises their condition in 2009. Many wharves are not operational for shipping purposes. There are plans to rehabilitate some of these in the near future. A disincentive is created for shipping operators when wharves are dilapidated and stevedoring facilities are not present. This can create a negative feedback cycle, where the lack of shipping causes further neglect of facilities. Farmers then have no transport facilities and stop producing cash crops. This kind of effect appears to have occurred in Pomio, so that cash cropping and the coastal freight business is now very depressed.

Shipping economics to Pomio, as elsewhere in the PNG islands region, are not favourable to many wharf points served on a regular basis. Instead, shipping companies can only regularly visit a few wharves, and normally need to be sure of full or near-full loads on their return trip to Rabaul. The current number of wharves is too many for commercial freight shipping services. Crops need to be consolidated at just a few wharves, by bringing them in either along roads or by outboard-motor dinghy. A combination of public and private investment is then needed at these commercial freight wharves. Public investment is needed in wharf infrastructure and feeder roads, while private investment is needed in buying points and stevedoring facilities. Private investment is likely to only occur at Uvol, Pomio and Palmalmal, with each creating its own transport hinterland.

Figure 30 shows that Pomio has few vehicular roads, so that most Pomio people cannot use vehicles to transport freight to coastal buying and shipping points. The map does however show the pattern of foot tracks in Pomio that link inland villages to the coast, and these would be likely roads if hinterland development were to occur. Realistically, only some of these routes could be maintained to vehicular standards for the foreseeable future. A feasible pattern of development would be a network of relatively short, low-cost dry-weather roads radiating from the commercial wharves into cropping areas, with foot tracks to more remote populations beyond. If agricultural growth is sustained, then the road network can be improved and extended.

The advantage of this pattern of transport development for the foreseeable future, is that it links populations to markets using a combination of low-cost feeder roads, private investment in buying and stevedoring facilities, and private investment in shipping. This spreads costs and stimulates

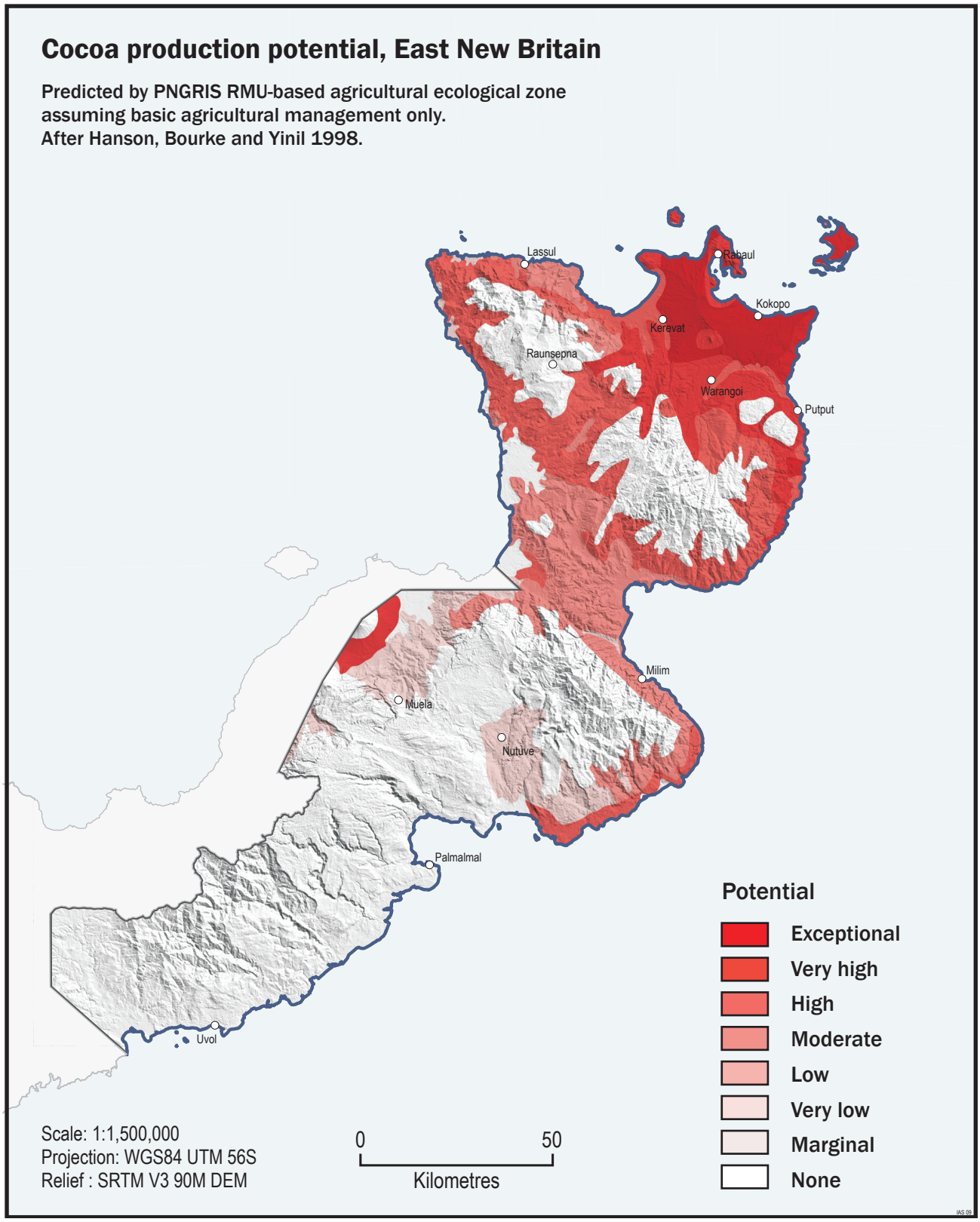


Figure 29. Cocoa production potential across East New Britain, predicted on environmental attributes. Potential production is greatest where production is already intense, which is in the north-east Gazelle area. According to the prediction, cocoa will yield satisfactorily in many places elsewhere in the Gazelle Peninsula that are currently unoccupied, including areas that the provincial government considers as growth areas. It will also grow in the northeast parts of Pomio district but not in southwest Pomio. This map must be treated with caution as it is only a prediction, and some earlier work was less optimistic about cocoa potential across ENB.

Table 9. Condition of ENB wharves and jetties, 2009.

Location	Status	Type	LLG
Watom	Not operational	Concrete deck	WAT
Molot	Operational	Concrete deck	DOY
Rakanda	Proposed	n/a	DOY
Lassul	Not operational	Concrete deck	LAB
Rabaul	Operational	Concrete deck	RAB
Matong	Operational	Concrete deck	CIP
Gonaile	Proposed	n/a	CIP
Pomio	Not operational	Concrete deck	CIP
Malakur	Not operational	Concrete deck	CIP
Palmalamal	Operational	Concrete deck	WPO
Uvol	Not operational	Concrete deck	MEL

Source: ENBPA Technical Services records and informant interviews. Note that there are other wharf and jetty locations in East New Britain, which were once important but now have low viability as commercial freight points.

multipliers in the local economy, rather than, as in the 'Pomio Highway' scenario, transferring all costs way from private enterprise, effectively shutting down commercial shipping, and creating a transport infrastructure monopoly in a government that cannot afford its upkeep.

4.4 Discussion of provincial market chain planning

Maintenance of the existing Gazelle road network is an unsustainable burden for the province. At the same time, Cocoa Pod Borer is poised to destroy much of ENB's export crop economy. The response to this threat must include development of a provincial agricultural market chain strategy. This will need to match agricultural opportunity to market chain road prioritisation, which will include cost-benefit analysis. The basis for a study to inform market chain planning was noted in section 4.1, involving economic modelling of the road network and careful spatial assessment of agricultural potential. This would downgrade redundant local roads, prioritise radial feeder roads, possibly recommend some new roads (especially feeder roads in Pomio region and the Baining lowland settlement belt), and probably favour trunk shipping routes rather than long distance roads. Cost effectiveness and sustainability are vital, otherwise the present problems will only worsen.

Hinterland provincial transport policy is largely concerned with transport to Pomio. Pomio, the most remote and disadvantaged area of the province, is currently poorly serviced by shipping. The province favours building a long distance road into Pomio. In part this is to serve the existing population, but also it is seen as a way to relieve population stress in the Gazelle by resettlement. Roads are expensive and rely on public investment, but public investment in PNG is much less than required; additional public financial burdens may not be addressed.

Shipping unlike roads, is based on private investment. Building a long distance road into Pomio shifts investment from the private sector into the public sector, yet government funds for continued road maintenance are unlikely when maintenance of current roads is a struggle. A long distance road would probably operate for about five years before falling into disrepair. In that time, existing shipping to the area would be put out of business and the district would be left with nothing. An alternative strategy would look at optimising shipping through a mix of private and public investment. Wharf facilities, an accepted public component of shipping, have been neglected in Pomio. This is a disincentive for shipping. Here is an example of cost-effective public investment to support private investment. Other public investment such as feeder roads and agricultural extension services would potentially increase freight tonnage for shipping demand as well as transport economic multipliers (increased cash leading to increased private demand for transport). A link road would eventually come to Pomio in future decades, once population and production levels will ensure that it is a maintained investment. For now, a public-private partnership strategy for improved shipping is the most viable option.

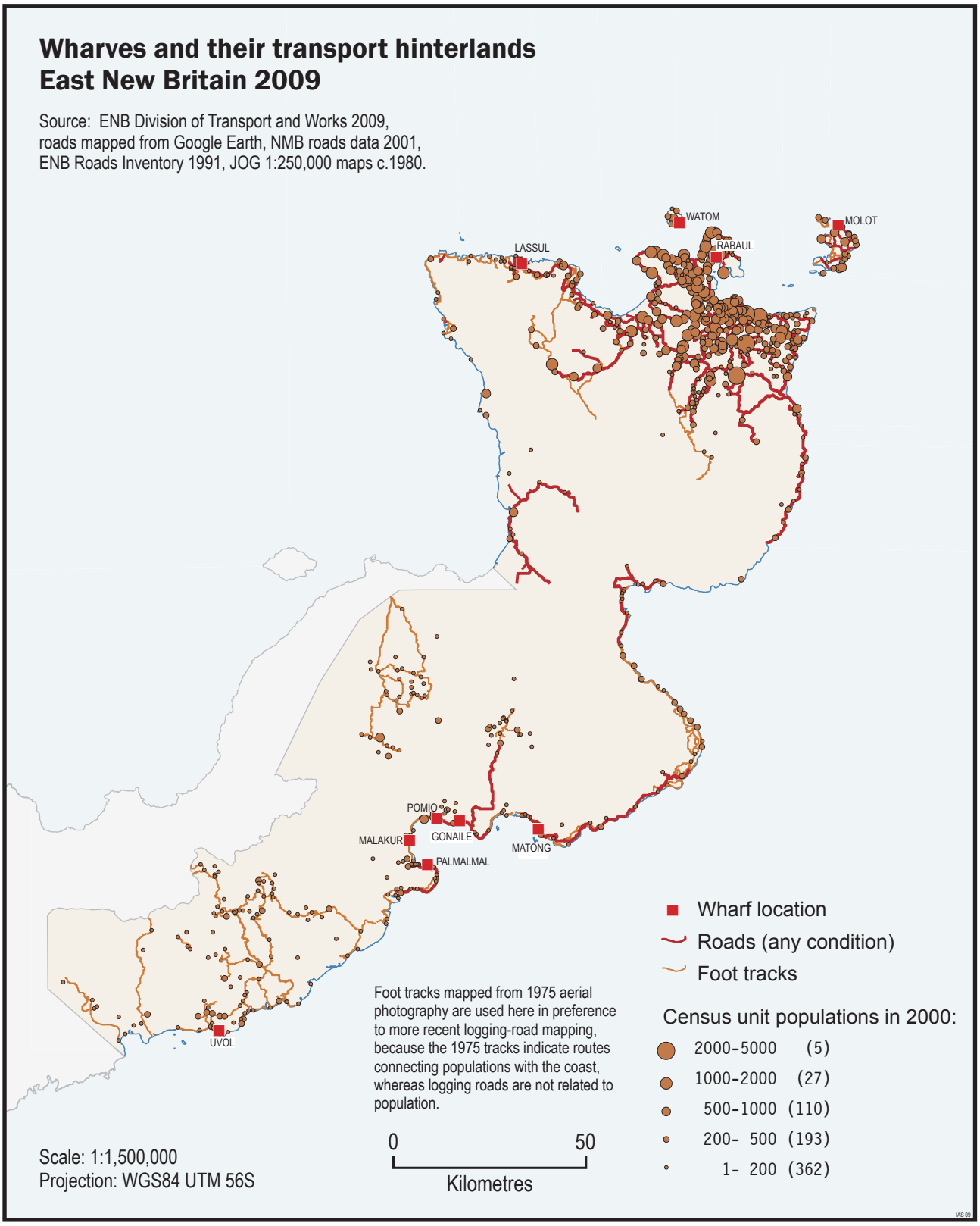


Figure 30. Location of economically viable wharves and jetties in East New Britain, in relation to the road network. Population density is represented by dot size. The Duke of York islands and Watom Island are reliant on shipping for transport of produce, as is the Pomio district. Feeder roads to Pomio district jetties remain undeveloped, inhibiting agriculture. However the low population densities in the Pomio district prohibit a cost-effective direct road connection to the northeast Gazelle, and instead favour shipping options.

5 Conclusions

This study has used a fresh approach to development assessment, by using spatial analytic methods to create an overview of roads in market chains in one of Papua New Guinea's most important socio-economic landscapes. The study has spanned three topics in separate sections: the role of roads in Gazelle Peninsula market chains, effectiveness of roads in the post-eruption restoration, and a forward-looking assessment of roads in East New Britain provincial development planning.

Uneven development in East New Britain

Development in East New Britain is confined to the northeast Gazelle Peninsula, an area covering about 10% of the province. Export crop production, services and population are strongly concentrated in this small area. This concentration is due to environmental and historical factors. The other 90% or so of the province, namely the Pomio and Baining regions, are strongly disadvantaged, with low production, inadequate services and sparse population. This gives the province a divided characteristic between 'haves' and 'have nots', and is the backdrop to development planning issues in the province.

Provincial market chains in crisis

Typically the transport linkages in a market chain are made of many capillary routes in cash-crop areas feeding into a trunk route, which leads to an export shipping point. Market chains function to generate rural income by harnessing efficient transport to market, which improves profit on labour. In northeast Gazelle, the road network has developed over decades of crop production into a tightly bound cluster of feeder roads, with a short trunk road to the close-by port of Rabaul. The very short trunk road length allowed road funds over time to be used for building the dense feeder road system. As more feeder roads were built, more agricultural potential was tapped, which in turn generated revenue for more roads. In recent decades this feedback cycle slowed down as the network reached the edges of the best land, transport costs rose with distance, and the burden of maintaining the existing network rose.

In the rest of the province, feeder roads are very few, but those that do exist lead to coastal shipping points. Trunk freighting in those areas is by small coastal vessels, which pick up produce from the small wharves and deliver it to Rabaul port. The province exhibits two very different types of market chain: a small high-traffic road-based one, and a large low-traffic sea-based one.

Both forms of market chain in the province are in crisis. Infrastructure has been declining in standard over the last 20 years, as the administration struggles to maintain its assets. The strong world market value of cocoa has masked the deterioration of the northeast road network, but the deterioration of the Pomio-Baining sea-based infrastructure has led to an almost complete cessation of production from these more economically fragile regions of the province.

Stresses are visible in terms of demographic movements within the province. Pomio and Baining are depopulating as people escape from the deep poverty in those regions and seek better opportunities elsewhere. Conversely, high growth rates around Kokopo and growth rates more than triple the provincial average are found in the new informal agricultural settlement belt where cocoa grows well. While population pressure in the northeast has worried the province for decades, a more serious crisis is looming with the spread of Cocoa Pod Borer and the spectre of consequent plummeting export income.

Current provincial roads strategy

The provincial administration realises it now has to reassess its planning and policies on a number of inter-related fronts. This study has begun a process of grappling with these challenges, based on spatial analysis and drawing from the retrospective understanding it has built up. Currently the province is basing its planning on its 'growth centre strategy' developed in 2003, the Pomio Development Plan of 2005, and long-standing ideas for a trans-New Britain highway. These plans are centred around a roads-based approach to development. This is influenced by experience

of the strong effectiveness of the northeast Gazelle road network. The approach calls for long-distance roads through Baining into Pomio and connecting to West New Britain. These would act as trunk roads to bring produce in from remote areas, and, seen as just or even more important, act as growth corridors that would see people move out of the northeast to relieve population pressure. This out-migration policy was given fresh impetus by the relocation away from the volcanic hazard zone around Rabaul under the Gazelle Restoration Program.

Profitability-based principle of road network utilisation

The present study has argued for a different approach. Firstly, patterns of road use in various market chains found in the northeast Gazelle were studied. This found that roads promote agricultural development only when producers can use them to tap potential for profit. Cocoa is the clearest successful example of this. Roads are used extensively in the case of cocoa because crop value is relatively high, and freight cost is relatively low, so that worthwhile profit is the outcome. Conversely, even when roads already exist, they are not used when transport costs are high in relation to the income received from the activity, i.e. when transport costs make the activity unprofitable. This was seen in the case of fresh produce marketing. Importantly, roads in themselves cannot create growth, nor will growth necessarily occur even if roads are coupled with agricultural potential. In other words, transport costs are the key factor. It is these, in relation to crop values, that determine the primary driving force in road use: profitability.

Low budgets and deteriorating roads

Secondly, the study measured the condition of roads in the northeast Gazelle as they are now, against their condition 20 years ago. Even with the substantial funding for road restoration as part of the Gazelle Restoration Program, road condition has deteriorated overall. Almost half the roads are now in either marginal or poor condition, whereas in 1990, the figure was just under 10%. The province is unable to sustainably maintain the 605km of roads it is responsible for. In the province this has vindicated criticism of legislative changes in 1995 that saw a decrease in provincial revenue available for roads, and encourages calls for greater provincial autonomy. Given the looming crisis of Cocoa Pod Borer, autonomy may be a poorer insurance than remaining in the national revenue pool. In any case, the primary issue is how to most effectively deploy the available funds. Two implications arise here from the general deterioration of the road network. One is, can the existing network be managed more optimally, and secondly, what are the implications for the proposed long-distance roads?

Bringing optimal management to the existing network

By analogy, if market chain transport links are like a tree with its trunk and branches, the northeast Gazelle network, now the result of more than one hundred years of plantations, cocoa projects and other endeavours, resembles a tangled bush. It may be possible to prune the network into a more efficient form by prioritising the feeder routes that radiate out from the trunk road, while cross-linking roads – the 'tangle' – are downgraded, especially in areas no longer highly productive. GIS analysis of agricultural potential, section-by-section freight volume modelling and transport costs, linked to road maintenance costing and improved inventory management, would provide a rational basis for this prioritisation. The best combination of these factors will increase the overall productivity of the network. Much of the data can be derived from the present study. This optimisation would also need to consider redefinition of network patterns coupled to agricultural diversification strategies in response to Cocoa Pod Borer.

Long distance trunk roads are not the answer for ENB's remote areas

If all the long distance roads proposed for the province were built, this would add another 490km to the existing 605km of provincial roads. The maintenance cost implications can be gauged by taking for example the 290km long road from Rugen Harbour to Palmalmal, proposed in the Pomio District Development Plan 2005-2010. At a likely maintenance cost of K12,000/km per year (not including construction), maintenance would cost at least K3.5M per year, not

allowing for the difficult terrain or including bridge maintenance. The average ENB provincial roadworks budget over the last five years has been K4.9M. Maintenance of this new road would be completely unsustainable. Given the low agricultural output that could be expected from Pomio, the road would also have an extremely poor cost-benefit ratio. In addition, very high costs for long-distance road freighting of produce would negate profit to crop producers. In terms of market chain economics, long roads in East New Britain are the wrong tool for the job. Some of these roads are proposed national roads. If asked to contribute, potential donors should engage in a formal cost-benefit analysis first.

Sea-linked market chains are the cost-effective, sustainable solution

The emphasis on roads as the only option for market linkages originates from the different circumstances of mainland Papua New Guinea. In this logic, if northeast Gazelle has benefitted from roads, then a scaled-up version covering the whole province should also work. It won't, because of the impossible maintenance costs and extremely poor cost-benefit ratio just explained. A better solution comes from recognising the form of market chain development that already exists around the East New Britain coast: a sea-linked market chain. This is a low cost, robust asset to the province, but currently unrecognised for what it is and very badly neglected. Cost of sea freighting crops from Pomio to Rabaul are comparable to the costs of freighting crops within the northeast Gazelle area to Rabaul. Unlike the huge costs that would face producers if they were to freight crops by road from Pomio to Rabaul, use of shipping allows them to make a profit.

A sea-linked market-chain model for Pomio

If the existing sea-linked market chain was working effectively in Pomio, then producers could take crops to shipping points by feeder tracks and roads or for some coastal villages, by short dinghy journey. The shipping points would have basic stevedoring facilities including a goods shed, surfaced vehicle loading area, wharf, communications, and a buying agent/stevedore/caretaker. In addition, agricultural technical services would help producers find and manage the best crops for their situation. As production slowly increases, shipping would become more profitable because freight would be loaded both ways. More store goods would be brought into Pomio because of the extra income, and more crops would be back-freighted out to Rabaul. Shipping services would become more frequent as a result. As the trade builds up, foot tracks could be upgraded to vehicular dry-weather roads, section by section, beginning from the coast. Eventually, the dry weather feeder roads radiating from the shipping points could be upgraded to all-weather roads, as long as freight traffic justifies this on a cost-benefit basis.

Leveraging private investment in the Pomio market chain

A compelling argument for a sea-linked market chain is that cost to government, both for initial construction and then for maintenance, is very low. This is because unlike trunk roads, sea lanes need no maintenance. This leaves the cost of a few wharves, and of feeder roads. 'Good enough' feeder roads can be maintained for dry-weather-only access to shipping points at a very low cost. A combination of public and private investment is needed at the shipping points. While public investment is needed in wharf infrastructure and feeder roads, private investment is needed in buying points and stevedoring facilities.

For cost reasons, shipping companies can only regularly visit a few wharves. They need to load quickly, and normally need to be sure of full or near-full loads on their return trip to Rabaul. An optimal number of wharves, probably less than those currently existing in Pomio, needs to be chosen for commercial development. Crops need to be consolidated at these fewer wharves, by bringing them in either along roads or by outboard-motor dinghy. The optimum number of wharves is then a trade-off between feeder route distance and shipping cost ceilings. A further consideration is the need for private investment in buying points and stevedoring facilities at the shipping points, which is more viable when higher turnovers are involved. Given these demands, commercial development is likely to occur only at Uvol, Pomio and Palmalmal, with each creating its own transport hinterland.

Initially, the feeder network should be made of relatively short, narrow dry-weather roads radiating from each commercial wharf into nearby cropping areas, with foot tracks to more remote populations beyond. If agricultural growth is sustained, then the road network can be improved and extended later. This is much the same as the way the northeast Gazelle network was developed a century ago. Wharves should be built with sustainable maintenance in mind, by local contractors using repairable local timber rather than by contracted-in engineers with concrete. Cost-effectiveness and sustainability are key issues.

The advantage of this pattern of transport development is that it links populations to markets using a combination of low-cost public investment in feeder roads and wharves, and private investment in buying and stevedoring facilities, and in shipping. This spreads costs and employment, and stimulates multipliers in the local economy; rather than, as in the 'Pomio Highway' scenario, creating a transport infrastructure monopoly in a government that cannot afford its upkeep, while effectively shutting down commercial shipping.

PPII roads provide an example of cost-effective feeder road maintenance

A good lesson for feeder road strategy came from the Provincial Performance Improvement Initiative (PPII) in East New Britain. This program was supported by the AusAID Sub-National Strategy to improve the performance of provincial governments in PNG. From 2005 to 2009 K1M a year was provided through the PPII to ENBPA. The provincial government was free to use these funds in a variety of budget areas. It mostly chose to fund road projects.

Two approaches were tried by the province. Initial remedial work was carried out on two roads leading to remote communities. Each road was about 30km long, meaning that the initial work touched about 10% of the provincial road stock. The result was vehicle access to these remote villages for the first time in years, although the roads remained rough. Immediate impact was felt in both places, with market access stimulating new agricultural production. The later two years of funding focussed on higher quality upgrades to shorter sections of road, each about 0.7 to 1.9km long, which affected only 1% of provincial roads. The impact of the later road work has not been as cost effective as the earlier work, with regard to social and economic benefits. Superior access was provided on these very short sections but a rougher, cheaper, road upgrade would still have enabled adequate access. Spreading the funding thinly over the road network is a better way to achieve the goal of providing market and services access, especially to remote communities.

The lesson from the PPII example is that moderate levels of funding, when well-targeted, can produce dramatic improvements in community connection to markets. In building feeder roads, it is better to use available funds on low-cost rudimentary road upgrades to many communities rather than high-cost high-quality roads to only a few communities, because overall market access outcomes are improved when the low-cost option is chosen.

Gazelle restoration program strategy: roads as links in relocation

Study conclusions now shift to the Gazelle Restoration Program (GRP). Program strategy was simple in structure, although this simplicity was obscured by a much more complex program implementation. Under twin goals of i) socio-economic restoration to at least pre-eruption levels and ii) relocation away from the hazard area, the program's three basic objectives, as interpreted from program documents, were a) relocation of urban infrastructure, services and population, b) relocation of rural populations, and c) restoration of social and economic linkages. While this structure is clear in hindsight, it was not expressed succinctly at the time. It must be stressed that the program was not concerned with economic growth, but rather was for restoration of the *status quo*, albeit in a re-arranged landscape.

AusAID role emphasised trunk road linkage

A third of GRP funding went to roads, fulfilling the 'linkage' objective of the program strategy. AusAID was the second-largest donor, contributing a quarter of all funding. Over half of this was spent on roads, and of this amount, one half went to the Kokopo-Rabaul trunk road, another quarter

went to Kokopo urban main road construction, 15% went to the trunk-road alternative route and the small remainder to rural resettlement roads. AusAID's greatest investment was therefore in trunk road linkage, but all roads to new facilities, resettlement areas and in Kokopo town were provided satisfactorily with regard to function. The Kokopo-Rabaul road is the trunk link for most market and service chains running through the northeast Gazelle economic landscape. It was central to the success of the restoration program.

The role of the Kokopo-Rabaul road as the trunk route from the agricultural areas to the port was established in colonial times, and Kokopo town also had colonial origins. The reconstruction of the Kokopo-Rabaul road did not rearrange the existing road network, although urban relocation has shifted the centre of gravity in the network away from Rabaul. The main impetus for the large expenditure on the road was to augment its original market chain role by providing efficient high-volume low-cost freight linkage between the old port and the new township. The old pre-eruption road was widened and strengthened, and its sealed surface was renewed.

Functionality of the road has been reduced, although not yet critically, by mudflow siltation from slopes next to the road and from destabilised hinterland catchments. Roadside silt comes from sheet erosion of new ash falling from the ongoing Tavurvur eruption, and stream-deposited silt comes from extensive gully erosion, caused by recent intensive peri-urban settlement around Kokopo. The constant siltation poses both maintenance and engineering challenges that were not originally anticipated. In addition, a 3.6km long section of the road that was not in AusAID's original scope has never been sealed. While road freight is not yet deterred by the deteriorating condition of the road, it is certainly slowed down, especially in wet conditions. In future, unless remediated, the linkage will become very inefficient and costly for businesses reliant on it. Dysfunctional linkage to Kokopo will favour alternative development in Rabaul. At this stage it should still be expected that remedial maintenance by the road's owner, GoPNG, can keep the link open. Capacity for maintenance could be supported through national transport sector support programming. The road was built in 2000 to a design life of 20 years, so that reconstruction work should be considered for 2020. In view of the road's trunk status, reconstruction of the Vulcan section should be done in the short term, but engineered to ensure minimal mudflow silt build-up.

Post-eruption urban relocation was effective

Urban relocation of Rabaul to the new township built 26km away beyond the ashfall hazard zone at Kokopo has succeeded, but not entirely. Kokopo is now a large urban centre supported by strong private investment on the back of the original multilateral donor investment. Retail and service industries, along with some export processing was successfully relocated, taking with it most of Rabaul's urban population. Much of the private investment was attracted by the booming post-eruption reconstruction effort centred on Kokopo. Services, infrastructure and private investment have consolidated now in the town, so that the town should remain sustainable after the construction boom ramps down.

Post-eruption rural resettlement was not fully effective

Rural resettlement under the Gazelle Restoration Program failed to either replicate the high density, near-urban characteristics of the evacuated settlements, or provide low-density inland smallholder arrangements that could be a workable alternative. No disaster preparation was in place, so key decisions on rural resettlement were made hastily after the disaster. The Rabaul eruption hazard had been officially identified years earlier, so a disaster preparedness approach could have planned land acquisition and socio-economic modelling well ahead of the disaster.

The study found that although these features were lacking from the official scheme, compounded by delays in settlement construction, many people made these arrangements for themselves by informally moving to the Kokopo peri-urban area, or informally buying smallholder blocks from Baining landowners. A minority have moved back to their near-Rabaul land. The bulk of resettlement has ultimately been unofficial, unplanned and unfacilitated. The formal resettlement areas, their roads and other infrastructure are carrying a much lower population than planned.

Once remaining construction is completed, planning issues for the resettlement areas should be managed within the wider context of the whole lowland Baining new settlement belt.

Remaining issues for the post-eruption restoration

The port facility at Rabaul could not be relocated to Kokopo or elsewhere. A number of industries tied to the port could not move, and these have gradually attracted ancillary businesses and population back into the volcanic hazard zone, an unintended outcome. The costs of remaining in Rabaul for port-related businesses are high. A number of Rabaul businesses chose to leave East New Britain rather than relocate to Kokopo. The continuing ashfall creates high maintenance costs for the remaining major businesses. More may go, because there is no viable alternative port site nearby. The traditional importance of Rabaul as a shipping hub for the New Guinea Islands region, and hence for the economic strength of the province, has been impaired. Incentives for businesses to stay might work, and may be worthwhile to the province.

The K420K expenditure on the restoration program was necessary, but nevertheless has driven a 15-year construction boom that, as the program ramps down, risks an employment downturn. Creating alternative urban employment, linked to business diversification, should be a priority. The strategy could be to capitalise on the town's low-crime, high-skills, new-infrastructure status to attract new business. The strategy should synergise with agricultural diversification.

Wider challenges and planning issues for the province

The focus on post-eruption restoration in the northeast Gazelle Peninsula has left the rest of the province neglected for over a decade, with poverty in those areas now severe. This must be addressed, as discussed above with regard to remote area market chains.

The province hopes that long distance trunk roads to remote areas will not only address development needs for the rest of the province, but will draw people out of the northeast Gazelle into these remote areas, and so relieve population pressure in the northeast. At this 'big picture' level, the evidence points instead to accelerating intensification in the northeast, rather than any decentralisation. The dynamic of intensification is driven by people crowding in to where they see opportunities for a better life, especially the Kokopo peri-urban area and the lowland Baining new settlement belt where per-capita incomes are high. These areas were identified in mapping of economic zones by the present study. Only quite enormous agricultural development outside the northeast, of which there is no sign at present, would reverse the intensification trend. Planning now needs instead to pay more attention to the realities of managing, and benefiting from, northeast Gazelle intensification rather than hoping to turn the tide. By neglecting to address these realities, social disadvantage could easily set in, especially in the new settlement belt, leading to Port Moresby-like problems for the province. LLG boundaries as they are now, hinder this management by cutting across areas of similar demographic and economic characteristics. If the LLG boundaries are reviewed sometime, the economic zones could be the basis for a more efficient realignment.

Cocoa Pod Borer is a major threat to the province. Key stakeholders are already developing pest management and crop diversification strategies in response. The market chain planning process called for above, needs to be coupled to this latest agricultural planning. The provincial growth centre strategy and district development plans need to be reviewed in the light of the issues around road economics that have been discussed, as well as a much more adequate analysis of agricultural potential, and also in light of the realities of demographic and economic growth trends in the province. Long term trend prediction should begin to take climate change into account as a game-changer of even greater proportions than cocoa pod borer.

Building on the insights of the present study, new planning should be based on the premise of access to opportunity, the reality that market chains are driven by profitability rather than infrastructure, and the need to leverage private investment for sustainable development.

5.1 Recommendations

This final section of the report provides actionable recommendations. These should be considered along with the general advice and lessons learned in the report conclusions. The recommendations are addressed to the provincial level of planning. Development partners including AusAID will need to assist if the recommendations are to be acted upon. The general recommendations and lessons learned may also have wider application beyond East New Britain.

Optimise the northeast Gazelle market chain road network

The network is in a crisis of deteriorating roads and low budgets. Roads in the network need to be prioritised on a rational basis, to make the most of available resources.

- Prioritise the most productive roads, using GIS-based network analysis of agricultural, transport and maintenance costs and benefits across the provincial roads inventory.
- Plan around agricultural diversification in response to Cocoa Pod Borer and climate change.
- GoPNG national transport development methodologies for prioritising road infrastructure could consider using similar spatial modelling techniques nationally.
- Adopt sustainability and cost-effectiveness as primary requirements.

Develop sea-link market chain access for remote disadvantaged areas of ENB

Uneven provincial development must be urgently addressed. Proposed long distance roads to Pomio and Baining areas are currently favoured for development, but without doubt are economically unsustainable. A cost-effective, but neglected, sea-linked market-chain already exists around the East New Britain coast and should be developed.

- Private investment in shipping and local buying/stevedoring must be encouraged.
- The number of wharves for commercial development should be optimised.
- Rehabilitate wharves, designed for sustainable local maintenance.
- Build low-cost feeder roads from wharves to main agricultural areas.
- Extend agricultural technical support to remote area producers.
- Adopt sustainability and cost-effectiveness as primary requirements.

Improve the condition of the Kokopo-Rabaul Road

The road is in a passable but deteriorating state. Unanticipated siltation, maintenance and a long unsealed section are the main issues. The road was built by AusAID in 2000, for a design life of 20 years. It a national road, and a vital trunk route.

- Capacity for maintenance should be addressed through national transport sector support.
- Reconstruction of the Vulcan section should begin in the short term.
- In view of the design life, major reconstruction work should be considered for 2020.
- Engineering design on this road should from now on try to minimise silt build-up.

Improve planning for emerging challenges in northeast Gazelle

The northeast Gazelle Peninsula is facing a number of present challenges, including falling agricultural income due to Cocoa Pod Borer, decline of Rabaul port, ending of restoration-based economic input, land pressure around Kokopo and rapid in-migration and population growth in the lowland Baining settlement belt. Climate change is a serious longer term issue.

- The ENB growth centre strategy and district development plans need to be reviewed in the light of findings in this study around road economics and agricultural potential.
- Province needs to adopt new planning that manages, and benefits from, northeast Gazelle intensification rather than hoping to turn the tide with out-migration policies.
- Planning for Kokopo urban business diversification needs to begin.
- Planning for market chains and agricultural diversification should begin with the data in this report on roads, agricultural potential, demographic trends and economic landscape analysis.

Endnotes

1. Annual population rate of change, ENB 1980-2000 was calculated with Excel spreadsheet function "RATE". For example on row 39, if Column D = Pop_sum_1980 and Column E = Pop_sum_2000, then Pct_change = RATE(21,,-D39,E39), where the '21' refers to the interval in years between 1980 and 2000 figures.
2. Epstein 1969:267, Salisbury 1970. The remainder of the section on the new settlement belt was largely drawn from information provided by Patrick Varagat and Blaise Magaga.
3. Maps used for this summary of road network development were: 'Rabaul 4-mile Strategic New Guinea Series Rabaul First Edn.', compiled and drawn by 3 Aust Field Survey Coy., March 1943 SVY/006/007(P); map 'The Northern Gazelle Peninsula 1960' (Epstein 1968:55); Joint Operations Graphics 1:250,000 topographic mapping compiled 1981 but stating field data dated from 1975; Ove Arup Road inventory survey mapping, 1990.
4. Annual series of trading license receipts were sought from LLG offices, but collection was not complete. Complete liquor licensing records had been obtained and were used instead for mapping. Actual retail turnover is not indicated by the license receipts, only location. Beyond the urban centres, most liquor licenses are issued for bottle shops, which are widely distributed. Bottle shops sell small quantities of beer affordable by many people.
5. East New Britain Provincial Government 1995 budget.
6. A damage estimate attributed by later documentation to the following report but not actually present in it: Australian International Development Assistance Bureau (AIDAB). "Rabaul Volcanic Disaster Needs Assessment Mission. Final Report". November 1994. Photocopied document. 144p. incl. appendices.
7. "Rabaul Volcanic Eruption: preliminary urban planning study". Dept. Physical Planning and Environment, Boroko, April 1984.
8. East New Britain Provincial Government 1997 budget. Gazelle Restoration Authority Act was passed on 07/02/1995.
9. East New Britain Provincial Government 1995 budget.
10. Budget speech in ENB Provincial Govt. 1997 budget, and (for both ITRP and MTRP objectives) GRA briefing papers 2008.
11. "Kokopo-Rabaul Road Upgrade: Final Report July 1998." Branko Cerecina. GRA/ENBPA. 48pp + appxs.
12. During the present study, no preliminary planning studies were found for the formal resettlement schemes. This may be because none were carried out in the haste of quick response to the eruptions.
13. Ekonia Tomalana, spokesman for Tavana, Valaur and Latlat villages told Caspar Towaninara (Melanesian Research Institute, Goroka) that "where the temporary road is today, our homes, dwelling grounds, garden and cemeteries lie below and we consider this an insult and trespassing." Towaninara, C.G., 2000. The 1994 Rabaul volcanic eruption: human sector impacts on the Tolai displaced communities; www.buai.com accessed July 2009.
14. "Gazelle Road Reconstruction Project Papua New Guinea: Feasibility study and project design document, Final report, November 2000". Prepared for AusAID. 40p. + appendices. See page 6.
15. Reports on this issue include: "Gazelle Peninsula Soil Erosion and Conservation Program: A project formulation document 15th October 2007", ENBPA Provincial Disaster Office (photocopied document, 17 pp); "Soil erosion and conservation Program: Method of planning for disasters" by Hiroshi Shimizu, 2007, under auspice of OISCA International (comb-bound Powerpoint presentation slides, 15pp).
16. Briefing paper to ENBPA Senior Exec. Management, 3pp., n.d., 2009. In 2007-08 the amount was not constant, but still averaged at K1M per year: in 2007, K0.5M was awarded, but the following year the amount was 1.5M.
17. The original inventory was compiled as: "East New Britain Provincial Government. Provincial Roads and Bridge Inventory. Prepared by Ove Arup and Partners Pacific, July 1991", volumes 1A to 1E. The original inventory covered all of East New Britain, the present study inventorised just the northeast Gazelle roads (corresponding to volumes A to D of the 1991 inventory). Road mapping was completely redrawn, mostly from polyline tracing of roads off high-resolution Google Earth imagery, with use of National Mapping Bureau national roads mapping data where Google Earth imagery resolution was too coarse, and with reference to the JOG 1:250,000 mapping from 1981. This new data was overall cleaner and more reliable than NMB data. Roads were segmented into inter-node lengths, using as far as possible the same nodes defined in the 1991 inventory. Data fields were then built up for each road segment, taking 1991 road condition, road surface and agency responsible data, joining to it road condition, road surface and agency responsible data provided orally by Alan Tovue, Adviser to ENBPA Division of Infrastructure, in July 2009. Road segment lengths were measured from the new mapping. Road condition assessment in 2009 is inaccurate to the extent that within each road segment the condition can be variable. In such cases, the average condition along the length was assumed.
18. Gazelle Peninsula Regional Plan. East New Britain Provincial Administration and Gazelle Restoration Authority. "Prepared by Urban and Regional Planning Project Team with assistance from AusAID and GRA". Kokopo: ENBPA. A4 format, xv + 231p. (Most of the report is background material. The actual strategy is contained in pp. 220 ff. and "Map 6. Proposed Growth Centres"). A growth centre concept was introduced in ENB in the Provincial Integrated Development Plan of 1986, although work on the current plan began in 2000 (see budget speech, ENB Prov. Govt. 2000 Budget).
19. ENB Provincial Integrated Development Plan, 1986; also Rabaul Volcanic Preliminary Urban Study, National Planning Office, 1984.
20. The 2003 study did not include Pomio district, but a parallel planning process, the ENB Economic Development Plan 2003-2033, and the slightly later Pomio District Development Plan 2005-2010, both extend elements of the growth strategy to Pomio District.
21. 'East New Britain Corporate Plan'. Dated 21 September 2006. Published 36p. ill. A4 colour brochure.

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Appendices

Appendix 1. Study team members

Scoping stage, East New Britain 09 Sep. 2008 to 18 Sep. 2008
Dr Ian Scales, independent consultant, team leader.
Ms Michelle Lowe, Director, Program Quality and Review, PNG Group, AusAID.
Dr Indra Thappa, Program Officer, Program Quality and Review, PNG Group, AusAID.
Ms Dorothy Luana, Senior Programme Officer, Sub-National Strategy, ENB office, AusAID.
Ms Belinda-Maree Gara, Program Officer, Aid Coordination & Monitoring Directorate, Department of National Planning & Rural Development, GoPNG.
Mr Xystus Kinala, Adviser, Division of Planning and Research, ENBPA.

Main fieldwork stage, East New Britain 24 Feb. 2009 to 16 Apr. 2009
Dr Ian Scales, independent consultant, team leader.
Ms Janet Donnelly, Manager, Evaluation and Reviews, Program Quality and Review, PNG Group, AusAID (present 12 Mar 2009 to 19 Mar 2009).
Ms Dorothy Luana, Senior Programme Officer, Sub-National Strategy, ENB office, AusAID.
Mr Xystus Kinala, Adviser, Division of Planning and Research, ENBPA, and later,
Ms Molly Waninara, Adviser, Division of Planning and Research, ENBPA.

Appendix 2. Key informants

Lucas, ENBPA Division of Infrastructure; Chris Agi, ENBPA Division of Health; Theresa Arek, Pacific Spices P.L.; Alphonse Bera, ENBPA PPII Project Manager; Munden Bray, CPB Project, CCI; Fidelis Bola, Adviser, ENBPA Division of Health; Robert Bola, United Church education office; Peter Buek, GRA; Adam Butler, Shipping Manager, Agmark; Catherine Cameron, PNG Balsa; Mary Dadatliu, Acting Advisor, ENBPA Div. Lands and Physical Planning; Janet Dominic, ENBPA Div. Human Resources Development; John Eddison, Engineer, GRA; Peter Hooper, Coconut Products Limited; Bruce Jackson, Engineering Advisor PSSP PMC2; Hosea John, Provincial Administrator, ENBPA (2008), Provincial Administrator ENBPA (2009); Vajala Karthik, CPL; Noel Keli, GRA; Vitus Koian, Provincial Works Manager, PNG Dept. Works, Kokopo; Dr Samson Lau, CCI Kerevat; David Loh (now deceased) PNG Growers Association, Kokopo; Bernard Lukara, Deputy Administrator, ENBPA; Arthur Luluai, Information Officer, United Church Health Service, ENB; Joachim Lummani, CCI Kerevat; Blaise Magaga, Adviser, ENBPA Division Primary Industry; Levi Mano, ENBPA Deputy Administrator, Policy Planning and Evaluation ENBPA; Apelis Marut, ENBPA Division of Education; Graeme McNally, Agricultural Production Manager, Agmark; Hubert Minana, Lands Project Officer, ENBPA Div. Lands and Physical Planning; Francis Minbuna, PNG Cocoa Board; John Moxon, Director, NARI; Alfred Nongkas CCI Kerevat; Wesley Pagot ENBPA Division of Human Resources Development; George Pamel, PNG Cocoa Board; Claire Parek, PNG Cocoa Board; Pomio focus group (Peter Mungunkia, Steven Kestapua, Casper Pakovua, Veronica Pulkapo, Demien Pilkapo, Paul Amet); John Robin, President, Plantation Association, Kokopo; Peter Sharp, Rabaul Shipping; Raphael Tapim ENBPA Div. Planning; Pius Tawy ENBPA Division of Education; Donald Terarup, ENBPA Division of Commerce, Industry and Tourism; Alan Tovue, Manager, ENBPA Div. Infrastructure; Hosea Turbarat, Manager, IATP, Vudal University; Patrick Varagat ENB Coffee Growers Cooperative Association; Cleopas Warpit, Vunadidir resident and ENBPA youth & sport representative; Nathan Wartovo, PNG Cocoa Board; David Yinil, CCI Kerevat.

Appendix 3. Geolocated 2000 census data.

East New Britain geo-located Census 2000 census unit population data

Filename: ENB_C2000_CU_WGS84Z56.TAB
Projection: WGS84 Zone 56 South
Source: Census Unit Register, East New Britain Province, 2000 National Census, National Statistical Office, Port Moresby. Geolocation source: see below.

Total records: 755
Population sum = 220,133 which is equal to official tally.

The tabulated data here was compiled from the complete Census 2000 census unit register for ENB, to which point coordinates were added from a number of sources. Most points are taken from National Mapping Bureau GPS data. However some of these data points were wrong, and about 15% of census units had no NMB data point. For these missing points, location was found by a variety of means, always attempting to be as accurate as possible. In some cases CU names were adjusted to accepted spellings, or to standardise or for clarification. Some locational errors will still exist, but overall this dataset is clean and superior to the official data. Errors which may exist in the original census count are inherent and still remain.

Coding for geolocation quality (GEOQUAL): 100K_TOPO = location from 1:100,000 topographic maps published in 1970s; Estimated = location from informants or guessed from other information; IAS_GPS = GPS location taken in 2009; NMB_APPROX = National Mapping Bureau GPS point re-adjusted e.g. for match to coastline; NMB_GPS = National Mapping Bureau GPS point from c.1999; OLD_GPS = National Mapping Bureau point apparently older, perhaps c.1995.

CU_NAME	POP	WARD_NAME	LLG_CODE	LON	LAT	GEOQUAL
2/22ND STREET	172	Rabaul Urban	RAB	407,600	9,536,109	ESTIMATED
ADMIN BLOCKS	71	Rabaul Urban	RAB	409,000	9,535,954	ESTIMATED
AINBULU	69	Waipo	MEL	238,253	9,346,962	OLD_GPS
ALASKAM	598	Alaskam	INB	370,891	9,504,175	OLD_GPS
AONA	234	Aona	WPM	282,665	9,365,359	OLD_GPS
AONA CATH. MISS	34	Aona	WPM	282,667	9,365,082	NMB_GPS
ARABAM	497	Arabam	SIN	401,734	9,491,858	OLD_GPS
ASILIGI PLNTN	106	Nangas	LAB	404,730	9,519,253	OLD_GPS
ATU	158	Atu	MEL	299,513	9,341,493	NMB_GPS
AVUNGI	76	Mandrambit	LAB	368,666	9,474,215	OLD_GPS
AWUNGI	57	Awungi	INB	395,739	9,505,511	ESTIMATED
BAAI	83	Baai	KOM	413,760	9,534,886	NMB_GPS
BAGETA	61	Bago	CIP	326,245	9,443,941	NMB_GPS
BAGITAVE	150	Bagitave	CIP	349,501	9,411,175	OLD_GPS
BAGO	178	Bago	CIP	318,130	9,428,215	OLD_GPS
BAIE	460	Baie	TOM	404,652	9,513,189	OLD_GPS
BAIEN (WEST)	164	Baien West	CIP	329,156	9,386,401	OLD_GPS
BAILU PLNTN	68	Palavirua	KOV	413,143	9,513,418	OLD_GPS
BAIN VLG	324	Bain	EPO	399,017	9,400,486	OLD_GPS
BAIRAMAN	117	Bairaman	WPM	322,205	9,362,258	OLD_GPS
BAKURIA NO.1	168	Kavale	CIP	350,242	9,413,314	OLD_GPS
BAKURIA NO.2	76	Kavale	CIP	352,753	9,415,663	OLD_GPS
BALADA	291	Balada	BIT	422,622	9,513,999	OLD_GPS
BALANATAMAN	628	Balanataman	BAL	413,510	9,521,310	OLD_GPS
BALANATANAM STREET	139	Rabaul Urban	RAB	409,000	9,534,528	ESTIMATED
BANANAPUNA	38	Manginuna	WPM	335,458	9,374,874	NMB_GPS
BARO	176	Kawa	CIP	352,263	9,391,075	OLD_GPS
BAROVON	485	Barovon	RAL	412,388	9,524,909	OLD_GPS
BASIS	162	Kolopom stlmnt	LAB	354,700	9,532,061	ESTIMATED
BATES STREET	124	Rabaul Urban	RAB	409,000	9,535,880	ESTIMATED
BEGAPUNA	65	Kerkernena	CIP	327,997	9,384,869	NMB_APPRX
BILATENA	113	Marmar	CIP	334,153	9,390,713	ESTIMATED
BILI	213	Bili	WPM	288,785	9,373,508	NMB_GPS
BILUR	224	Bilur	BIT	428,317	9,511,538	OLD_GPS
BIRAR	370	Birar	BIT	427,424	9,512,926	NMB_GPS
BIRIGI	253	Birigi	CIP	348,510	9,412,696	OLD_GPS
BISHOP STREET	188	Rabaul Urban	RAB	407,600	9,535,997	ESTIMATED
BITABAUR	650	Bitabaur	RAL	411,788	9,522,781	OLD_GPS
BITAGALIP	484	Bitagalip	KOV	420,867	9,516,085	OLD_GPS
BITAKAPUK NO.1	686	Bitakapuk No.1	TOM	407,694	9,515,547	OLD_GPS
BITAKAPUK NO.2	391	Bitakapuk No.2	TOM	406,980	9,514,445	OLD_GPS
BITAKAPUK NO.3	315	Bitakapuk No.3	TOM	408,120	9,512,986	OLD_GPS
BITAPAKA GOVT STN	86	Balada	BIT	422,552	9,513,170	NMB_GPS
BITAPAKA WAR CEMETERY	41	Balada	BIT	422,259	9,512,942	OLD_GPS

BITAREBAREBE	947	Bitarebarebe	KOV	416,120	9,518,922	OLD_GPS
BITARUGA	97	Malakuna	BIT	428,178	9,516,356	NMB_GPS
BITATITA	241	Bitatita	RAL	408,993	9,523,280	OLD_GPS
BOKONGTATAR	100	Pulpul	CIP	375,233	9,388,400	NMB_GPS
BOLWARA	73	Kolopom stlmnt	LAB	354,753	9,532,345	NMB_APPRX
BORENGPUNA (SAVENA)	113	Muela	CIP	322,485	9,421,615	OLD_GPS
BOVALPUN	73	Bovalpun	CIP	345,659	9,385,476	OLD_GPS
BRENNAN STREET	105	Rabaul Urban	RAB	409,000	9,535,418	ESTIMATED
BUBUANA PLNTN	132	Rieit	SIN	404,029	9,499,412	NMB_GPS
BUKA	136	Buka	CIP	365,767	9,384,385	NMB_GPS
BULUS	22	Marunga	SIN	391,960	9,451,189	OLD_GPS
BURIT	301	Burit	INB	385,353	9,512,863	NMB_GPS
BUROWEI	58	Makmak	MEL	252,659	9,337,916	OLD_GPS
BUTLIVUAN (PIRTOP)	311	Butlivuan	DOY	442,274	9,541,320	OLD_GPS
BUTUWIN HEALTH CTR	120	Kokopo Town	KOV	415,826	9,521,882	OLD_GPS
C.P.L.	451	Rabaul Urban	RAB	406,593	9,535,425	ESTIMATED
CATHOLIC MISSION AREA	203	Rabaul Urban	RAB	408,300	9,535,837	ESTIMATED
CHANEL COLL / MATANAVA	80	Kokopo Town	KOV	423,099	9,520,064	NMB_GPS
CLIFTON-KORERE STLMNT 1	78	Korere 1	KOM	415,538	9,508,377	ESTIMATED
CLIFTON-KORERE STLMNT 2	195	Korere 2	KOM	415,148	9,507,925	NMB_GPS
DADUL	274	Rieit	SIN	401,769	9,495,116	OLD_GPS
DAGA	30	Marevu	CIP	330,305	9,421,613	OLD_GPS
DEEPDENE PLNTN	51	Sunam	SIN	403,096	9,507,066	NMB_GPS
DELROY PLNTN	95	Rieit	SIN	402,752	9,497,296	OLD_GPS
DING STLMNT	43	Nangas	LAB	351,880	9,534,112	NMB_GPS
DRINA PLNTN	14	Kaiton	WPM	325,385	9,368,868	OLD_GPS
ESLETENAE	154	Raolman	MEL	285,969	9,344,258	OLD_GPS
EUNGA	58	Raolman	MEL	286,440	9,339,603	ESTIMATED
GALUWE	551	Galewa	CIP	331,974	9,389,339	OLD_GPS
GANAI	709	Ganai	BIT	426,290	9,504,275	OLD_GPS
GAR	254	Gar	SIN	429,903	9,479,231	NMB_GPS
GAROM	40	Lamarainam	INB	382,099	9,517,678	NMB_GPS
GAULIM	752	Gaulim	INB	399,509	9,509,412	OLD_GPS
GAULIM TEACHERS COLL	127	Gaulim	INB	398,946	9,508,933	NMB_GPS
GAVIT PLNTN	48	Nangas	LAB	349,156	9,535,270	ESTIMATED
GAVOGOPUNA	27	Olaipun	CIP	337,394	9,390,921	NMB_GPS
GELAGELA PLNTN	336	Gunanur	KOV	416,162	9,513,140	ESTIMATED
GELAGELA-BAAI SETLMT	509	Baai	KOM	414,496	9,512,891	NMB_GPS
GELAGELA-IAWAKAKA STLMT	59	Iawakaka	BAL	415,603	9,512,278	OLD_GPS
GELAGELA-MATALAU STLMT	754	Matalau	KOM	415,031	9,512,524	NMB_GPS
GELAGELA-NODUP STLMT	665	Nodup	KOM	414,679	9,512,972	NMB_GPS
GELAGELA-RABUANA STLMT	283		-	415,970	9,512,409	NMB_GPS
GELAGELA-RAKUNAT STLMT	360	Rakunat	KOM	415,214	9,513,299	NMB_GPS
GELIOI	65	Gelioi	CIP	353,366	9,415,069	OLD_GPS
GELOKPUN	45	Buka	CIP	367,802	9,387,848	NMB_GPS
GEORGE BROWN HIGH SCH	126	Totovel	LIR	392,355	9,527,666	NMB_GPS
GEORGE BROWN STREET	416	Rabaul Urban	RAB	408,300	9,535,955	ESTIMATED
GIETUAGANA	24	Gugulena	WPM	328,640	9,377,502	NMB_APPRX
GILALUM PLNTN	63	Londip	BIT	421,925	9,508,297	OLD_GPS
GORE STLMNT	161	Sunam	SIN	411,038	9,499,526	NMB_GPS
GOVERNOR HAHL DRIVE	19	Rabaul Urban	RAB	408,347	9,535,616	ESTIMATED
GRIFFITH STREET	120	Rabaul Urban	RAB	409,000	9,534,788	ESTIMATED
GROVES STREET	40	Rabaul Urban	RAB	409,000	9,535,019	ESTIMATED
GUAMA	38	Bili	WPM	290,244	9,373,186	NMB_GPS
GUGULENA	76	Gugulena	WPM	328,684	9,377,715	OLD_GPS
GULGUL	133	Lakiri	CIP	356,642	9,411,347	OLD_GPS
GUMA VLG	278	Guma	EPO	399,497	9,416,842	OLD_GPS
GUNANBA	987	Gunanba	KOV	411,249	9,518,370	OLD_GPS
GUNANUR NO.1&2	542	Gunanur	KOV	418,804	9,516,575	OLD_GPS
GWEPUNA	41	Puapal	WPM	326,450	9,378,256	NMB_GPS
HANAORIA	115	Pilematana	MEL	275,915	9,340,437	OLD_GPS
HARBOUR LANE	96	Rabaul Urban	RAB	407,600	9,535,689	ESTIMATED
HAUMAKIA	225	Haumakia	MEL	278,764	9,338,134	OLD_GPS
HELLINA	36	Uvol	MEL	273,774	9,334,525	NMB_GPS
HEPORA	167	Mininga	MEL	282,563	9,336,472	NMB_GPS
HETWARA	470	Manapki	INB	388,858	9,510,448	NMB_GPS
HOIOKLETENA	118	Pilematana	MEL	274,992	9,342,236	OLD_GPS
HOIYA VLG	274	Hoiya	EPO	383,603	9,432,000	NMB_GPS
HOSKINS STREET	153	Rabaul Urban	RAB	407,000	9,535,861	ESTIMATED
HOSLANA	38	Kenmininga	MEL	284,196	9,348,226	OLD_GPS
HULHUL	208	Haumakia	MEL	280,074	9,338,113	OLD_GPS
HULPUNA	60	Warale	MEL	261,224	9,360,417	OLD_GPS
IALAKUA	423	Ialakua	RAL	412,893	9,524,802	OLD_GPS
IAWAKAKA	485	Iawakaka	BAL	404,012	9,534,566	100K_TOPO
ILI	259	Ili	SIN	423,122	9,462,438	NMB_GPS
ILUGI PLNTN	40	Rieit	SIN	402,782	9,498,097	OLD_GPS
INAHELE (EINAHELEI)	249	Inahele	MEL	277,612	9,335,267	NMB_GPS
INDUNA PLNTN	73	Lat	SIN	429,993	9,491,488	NMB_GPS
INOLO	348	Inolo	DOY	442,041	9,535,650	OLD_GPS

INTAKE	27	Rieit	SIN	402,404	9,496,198	NMB_GPS
IRE	109	Kavale	CIP	351,791	9,414,307	NMB_GPS
IRENA	278	Irena	WPM	327,401	9,379,015	OLD_GPS
IVERE	341	Ivere	INB	397,906	9,508,786	OLD_GPS
IVON STLMNT	234	Sunam	SIN	410,211	9,502,248	NMB_GPS
IWAI (GUM)	422	Guma	EPO	397,080	9,419,719	NMB_GPS
KABABIAI	899	Kababiai	DOY	441,262	9,539,160	OLD_GPS
KABAGAP	237	Malakuna	BIT	432,576	9,518,725	NMB_GPS
KABAIRA VOC. SCH	24	Volavolo	LIR	390,081	9,531,541	OLD_GPS
KABAKADA VLG	709	Kabakada	LIR	399,679	9,535,190	OLD_GPS
KABAKAUL	430	Kabakaul	KOV	425,430	9,520,139	OLD_GPS
KABALEO	181	Takubar	KOV	421,435	9,517,445	OLD_GPS
KABALEO TEACHERS COLL	204	Takubar	KOV	421,468	9,517,793	OLD_GPS
KABAREKA	199	Sunam	SIN	408,342	9,499,350	NMB_GPS
KABATIRAI	209	Inolo	DOY	441,287	9,534,806	OLD_GPS
KABILOMO	930	Kabilomo	DOY	438,568	9,541,777	OLD_GPS
KADAKADA VLG	608	Kadakada	CGZ	401,551	9,526,409	OLD_GPS
KADAULUNG NO.2	643	Kadaulung No.2	INB	402,190	9,507,785	NMB_GPS
KADAULUNG STLMNT NO.1	629	Kadaulung No.1	INB	402,000	9,507,700	ESTIMATED
KAEMATANME	155	Bago	CIP	320,191	9,427,773	OLD_GPS
KAIKOU	81	Kaikou	WPM	277,622	9,374,853	OLD_GPS
KAINAGUNAN	652	Kainagunan	INB	397,728	9,507,287	OLD_GPS
KAITON	285	Kaiton	WPM	325,904	9,370,180	OLD_GPS
KAITOTO	224	Kaitoto	WPM	289,806	9,365,557	OLD_GPS
KALAMPUN VLG	287	Klampun	EPO	401,197	9,415,097	OLD_GPS
KALIP VLG	132	Hoiya	EPO	383,362	9,434,338	NMB_GPS
KAMAKAMAR	242	Kamakamar	BIT	426,744	9,512,352	NMB_GPS
KAMANAKAM	459	Kamanakam	INB	371,708	9,522,018	ESTIMATED
KAMAR	193	Marmar	BIT	428,616	9,509,261	OLD_GPS
KAMBUBU HIGH SCH	187		SIN	429,514	9,493,888	NMB_GPS
KANAKO	210	Poniar/Kanako	LAB	347,952	9,494,351	OLD_GPS
KANAMAWE	25	Marevu	CIP	328,677	9,423,552	OLD_GPS
KANGELONA	151	Kangelona	WPM	302,671	9,346,498	NMB_GPS
KAORO C/S AP	11	Mainge	MEL	296,134	9,341,952	NMB_GPS
KAPKENA	366	Kapkena	CIP	335,631	9,414,972	OLD_GPS
KARAVI	747	Karavi	KOV	414,650	9,521,422	OLD_GPS
KARAVIA (BAL)	489	Karavia	BAL	404,548	9,536,915	OLD_GPS
KARAVIA NO.1 VLG (CGZ)	561	Karavia No.1	CGZ	406,350	9,525,786	OLD_GPS
KARAVIA NO.2 VLG (CGZ)	351	Karavia No.2	CGZ	405,404	9,524,378	OLD_GPS
KARAWARA	380	Karawara	DOY	435,671	9,531,166	NMB_GPS
KARLAI PLNTN	111	Long	EPO	384,750	9,442,980	NMB_GPS
KARO	203	Karo	LAB	367,181	9,534,108	OLD_GPS
KARONG	267	Karong	SIN	414,256	9,451,644	OLD_GPS
KARU	237	Bilur	BIT	429,355	9,512,869	OLD_GPS
KASASKA	185	Malasaet	INB	383,254	9,511,003	NMB_GPS
KATAKATAI	412	Katakatai	BIT	420,502	9,512,864	OLD_GPS
KAUKUM VLG	388	Kaukum	EPO	386,530	9,429,247	OLD_GPS
KAUNGAROLE	91	Pakia	CIP	320,267	9,406,581	NMB_APPRX
KAVALE	156	Kavale	CIP	359,658	9,411,625	NMB_GPS
KAVUDEMKI VLG	153	Kavudemki	SIN	384,802	9,455,151	NMB_GPS
KELUGA	217	Pakia	CIP	322,739	9,405,627	NMB_APPRX
KENABOT PLNTN	521	Kokopo Town	KOV	418,552	9,519,122	100K_TOPO
KENMININGA	336	Kenmininga	MEL	280,086	9,347,917	OLD_GPS
KEREBA STLMNT	861	Kereba	INB	392,756	9,517,950	NMB_GPS
KERENGKORONA	84	Krengkorona	WPM	291,795	9,357,944	OLD_GPS
KERENGME	88	Tokai	CIP	359,510	9,389,949	ESTIMATED
KEREVAT 01	363	Kerevat Urban	CGZ	393,639	9,519,204	NMB_GPS
KEREVAT 02	577	Kerevat Urban	CGZ	394,200	9,518,813	NMB_GPS
KEREVAT CIS	654	Liaga	INB	394,761	9,511,199	OLD_GPS
KEREVAT L/LAND AGRI.STN	582	Kerevat Township	CGZ	392,372	9,521,088	OLD_GPS
KEREWA	82	Krengkorona	WPM	299,209	9,353,333	OLD_GPS
KERKERENA	112	Kerkernena	CIP	328,554	9,385,177	OLD_GPS
KIKITABU	668	Kikitabu	LIR	399,310	9,528,366	OLD_GPS
KILALUM	297	Guma	EPO	398,370	9,418,039	OLD_GPS
KILIGIA	75	Reigal	SIN	407,803	9,489,560	NMB_GPS
KINSENA	241	Kinsena	WPM	280,574	9,364,158	OLD_GPS
KIPKA	267	Mobisberg	LAB	363,797	9,530,572	NMB_GPS
KIVALONA	6	Ulutu	WPM	277,043	9,360,052	OLD_GPS
KLINWARA PLNTN	205	Ragaga	INB	371,490	9,529,420	ESTIMATED
KOILAU	54	Manigugule	CIP	332,015	9,431,294	OLD_GPS
KOKI	203	Lamarainam	INB	382,226	9,518,633	NMB_GPS
KOKOPO WARD 1	297	Kokopo Town	KOV	418,837	9,519,947	NMB_GPS
KOKOPO WARD 2	412	Kokopo Town	KOV	419,027	9,519,663	ESTIMATED
KOKOPO WARD 3	511	Kokopo Town	KOV	419,242	9,519,718	ESTIMATED
KOKOPO WARD 4	242	Kokopo Town	KOV	419,423	9,519,840	ESTIMATED
KOLAI	87	Matong	CIP	361,296	9,387,418	NMB_GPS
KOLOPOM STLMNT	189	Kolopom stlmnt	LAB	354,763	9,532,613	OLD_GPS
KOLWARA	27	Panarapka	LAB	344,202	9,508,752	OLD_GPS
KOMGI	262	Komgi	LAB	359,737	9,516,390	OLD_GPS

KORAI	412	Korai	BIT	426,340	9,512,052	OLD_GPS
KORERE 1	289	Korere 1	KOM	411,034	9,539,839	NMB_GPS
KORERE 2	306	Korere 2	KOM	410,481	9,539,771	NMB_GPS
KORPUN VLG	96	Raolman	EPO	392,885	9,396,526	OLD_GPS
KREKEMBAK PLNTN NO.1	100	Rieit	SIN	402,309	9,500,099	OLD_GPS
KREKEMBAK PLNTN NO.2	72	Rieit	SIN	401,916	9,500,208	OLD_GPS
KUKULU	95	Kaikou	WPM	278,508	9,375,677	NMB_GPS
KULA	175	Kavale	CIP	351,734	9,411,578	OLD_GPS
KULAUN (KULON)	230	Makurupau	BIT	430,514	9,514,238	OLD_GPS
KULIPUNA	37	Kaiton	WPM	325,928	9,371,541	NMB_GPS
KULIT	471	Kulit	INB	376,141	9,520,343	OLD_GPS
KULON PLNTN	32	Makurupau	BIT	431,000	9,514,349	OLD_GPS
KULONTO	29	Serenguna	WPM	301,802	9,363,284	ESTIMATED
KUMAINA	164	Kumaina	DOY	437,442	9,538,333	OLD_GPS
KUNAKUNAI	585	Kunakunai	RAL	409,029	9,520,646	OLD_GPS
KURAIP	855	Kuraip	LIR	403,066	9,531,633	OLD_GPS
KUREDAL	120	Watmetki	LAB	337,171	9,515,617	NMB_GPS
LABAM	219	Yayami	INB	378,460	9,516,844	ESTIMATED
LAKAER	60	Raolman	EPO	394,112	9,401,534	NMB_GPS
LAKIRI	282	Lakiri	CIP	356,156	9,412,559	OLD_GPS
LAKUNDA PLNTN	125	Palavirua	KOV	415,954	9,509,864	NMB_GPS
LALIKA	71	Gelioi	CIP	353,343	9,414,785	OLD_GPS
LAMARAIN	70	Lamarain	EPO	384,119	9,448,969	NMB_GPS
LAMBERAIN	419	Lamberain	INB	365,888	9,505,425	OLD_GPS
LAMPURU	110	Gelioi	CIP	352,512	9,415,458	OLD_GPS
LASA	89	Okempuna	WPM	289,168	9,372,617	NMB_GPS
LASSUL 1&2	186	Lassul	LAB	358,624	9,533,686	OLD_GPS
LASSUL SDO	66	Lassul	LAB	357,663	9,533,471	OLD_GPS
LAT	312	Lat	SIN	431,005	9,483,251	NMB_GPS
LATA/TONAMUSU	25	Poro/Salel	WPM	329,047	9,377,367	NMB_GPS
LATLAT VLG	304	Latlat	CGZ	403,970	9,527,452	NMB_GPS
LAU	95	Lau	WPM	314,679	9,355,659	OLD_GPS
LAUN	285	Laun	LAB	361,330	9,530,694	OLD_GPS
LAUP PLNTN	68	Sunam	SIN	407,375	9,505,860	OLD_GPS
LAUSUS	273	Lausus	MEL	273,183	9,338,130	OLD_GPS
LAVUGI	77	Yauyau	WPM	274,880	9,376,067	OLD_GPS
LEKEMPUNA	147	Ulutu	WPM	286,289	9,352,877	OLD_GPS
LELE	144	Muela	CIP	322,180	9,422,644	OLD_GPS
LIAGA	226	Liaga	INB	392,138	9,514,197	OLD_GPS
LILA	88	Krengkorona	WPM	292,338	9,353,581	OLD_GPS
LILINAKAIA	38	Nangas	LAB	350,841	9,534,704	ESTIMATED
LILON	148	Tokai	CIP	358,990	9,390,167	NMB_GPS
LIVUAN (KOV)	524	Livuan	KOV	423,221	9,516,707	NMB_GPS
LIVUAN (RAL)	812	Vunamurmur	RAL	408,991	9,522,181	NMB_GPS
LONDIP	219	Londip	BIT	426,937	9,506,605	OLD_GPS
LONG VLG	184	Long	EPO	383,171	9,437,777	OLD_GPS
LOP (RAOLMAN) VLG	147	Raolman	EPO	395,287	9,398,132	OLD_GPS
LOPUN	116	Waipo	MEL	245,874	9,342,274	OLD_GPS
LOPUNA	139	Kinsena	WPM	277,966	9,364,249	OLD_GPS
LUNGALUNGA VLG	605	Lungalunga	LIR	387,190	9,534,318	OLD_GPS
LUVAI	88	Lamarain	EPO	383,545	9,446,547	OLD_GPS
MAIHUNA (MANIHUNA)	16	Mainge	MEL	292,125	9,340,413	NMB_GPS
MAILIVUAN VLG	340	Malilivuan	LIR	389,108	9,532,047	OLD_GPS
MAINGE	210	Mainge	MEL	294,251	9,342,096	OLD_GPS
MAITAO	328	Maito	WPM	307,156	9,366,092	OLD_GPS
MAKMAK	38	Makmak	MEL	252,675	9,331,970	NMB_GPS
MAKURAPAU	620	Makurupau	BIT	428,975	9,513,897	OLD_GPS
MAKURAPAU PLNTN	139	Makurupau	BIT	427,451	9,513,801	OLD_GPS
MALABUNGA 1	234	Malabunga	INB	398,187	9,509,664	OLD_GPS
MALABUNGA 2	125	Malabunga	INB	398,605	9,510,180	OLD_GPS
MALAGUNA NO.1	977	Malaguna No.1	BAL	406,512	9,535,151	OLD_GPS
MALAGUNA NO.2	711	Malaguna No.2	BAL	406,251	9,534,131	OLD_GPS
MALAGUNA NO.3	816	Malaguna No.3	BAL	405,561	9,532,961	OLD_GPS
MALAI	44	Bairaman	WPM	322,417	9,363,307	OLD_GPS
MALAKUNA (BIT)	493	Malakuna	BIT	429,020	9,515,899	NMB_GPS
MALAKUNA NO.4 (KOV)	1045	Malakuna No.4	KOV	411,987	9,513,870	OLD_GPS
MALAKUR	215	Malakur	CIP	327,982	9,384,407	OLD_GPS
MALASAET	502	Malasaet	INB	376,871	9,506,462	OLD_GPS
MALBONI	294	Malboni	CIP	325,649	9,417,474	OLD_GPS
MALMAL	64	Malmal	WPM	329,961	9,377,585	OLD_GPS
MALMAL CATH. MISS	28	Malmal	WPM	330,200	9,377,700	ESTIMATED
MALMALUAN VLG	867	Malmalan	CGZ	404,957	9,525,042	OLD_GPS
MALOPUNA	75	Mapuna	WPM	288,526	9,364,633	NMB_GPS
MALPAS	25	Milim	EPO	394,161	9,422,806	NMB_GPS
MALUAN	34	Buka	CIP	369,586	9,382,755	NMB_GPS
MALUMAT	150	Makurupau	BIT	428,011	9,515,811	NMB_GPS
MALUSONA	81	Maso	MEL	284,186	9,341,000	OLD_GPS
MAMBUPUN	40	Tokai	CIP	357,970	9,390,242	ESTIMATED
MAMBUR	177	Palavirua	KOV	416,335	9,511,328	ESTIMATED

MANAKENG	67	Pakia	CIP	325,669	9,407,180	OLD_GPS
MANANE ENO	73	Serenguna	WPM	301,247	9,366,299	ESTIMATED
MANDRAMBIT	191	Mandrambit	LAB	362,109	9,476,895	OLD_GPS
MANDRESS PLNTN	185	Radingi	INB	375,972	9,523,388	OLD_GPS
MANDRESS STLMNT	702	Mandress stlmnt	INB	379,689	9,520,100	ESTIMATED
MANDRESS STN	30	Mandress stlmnt	INB	379,689	9,520,291	NMB_GPS
MANGINUNA	133	Manginuna	WPM	335,400	9,373,830	OLD_GPS
MANGO AVENUE	37	Rabaul Urban	RAB	409,000	9,535,600	ESTIMATED
MANIMBU PLNTN	80	Morokindam	LAB	335,213	9,524,314	NMB_APPRX
MANSIPANA	56	Muela	CIP	325,599	9,425,755	OLD_GPS
MANU (Bago)	89	Bago	CIP	318,082	9,430,074	NMB_APPRX
MANU (Olaipun)	55	Olaipun	CIP	336,607	9,392,479	ESTIMATED
MAOLENGPUNA	64	Pakia	CIP	323,741	9,407,918	OLD_GPS
MAPUNA	175	Mapuna	WPM	287,617	9,363,545	OLD_GPS
MARA	15	Irena	WPM	325,225	9,378,088	NMB_APPRX
MARABU	238	Marabu	SIN	418,278	9,487,337	NMB_GPS
MARANA	73	Manginuna	WPM	334,782	9,373,963	NMB_GPS
MARANAGI	92	Maranagi	SIN	404,893	9,484,764	OLD_GPS
MARAWA	292	Marmar	BIT	425,784	9,508,497	OLD_GPS
MAREN	381	Maren	DOY	440,537	9,543,255	OLD_GPS
MAREVU	105	Marevu	CIP	328,693	9,421,912	OLD_GPS
MARK	44	Merai	SIN	428,097	9,471,972	OLD_GPS
MARMAR (BIT)	284	Marmar	BIT	426,839	9,509,321	OLD_GPS
MARMAR (CIP)	326	Marmar	CIP	334,087	9,389,737	OLD_GPS
MARTIN PLNTN	44	Tavilo stlmnt	CGZ	394,787	9,523,072	NMB_GPS
MARUNGA HEALTH CTR	15	Marunga	SIN	394,200	9,450,400	ESTIMATED
MARUNGA VLG	339	Marunga	SIN	393,958	9,450,532	OLD_GPS
MASARAU	68	Masarau	SIN	388,800	9,450,450	ESTIMATED
MASI	72	Bovalpun	CIP	345,138	9,385,883	NMB_GPS
MASKILKILIE	133	Raolman	EPO	386,912	9,392,622	OLD_GPS
MASO	430	Maso	MEL	284,960	9,337,415	OLD_GPS
MASO COMM. SCH	59	Maso	MEL	284,400	9,337,400	ESTIMATED
MASUARI	188	Masuari	CIP	329,327	9,427,343	OLD_GPS
MATALA PLNTN	85	Lat	SIN	428,649	9,495,477	NMB_GPS
MATALAPUNA	55	Kinsena	WPM	278,460	9,366,503	OLD_GPS
MATALAU	66	Matalau	KOM	411,816	9,536,378	NMB_GPS
MATANAKUNAI	292	Matanakunai	LAB	354,247	9,462,173	OLD_GPS
MATAWAN (Serenguna)	19	Serenguna	WPM	305,475	9,363,799	ESTIMATED
MATAWANG (Ulutu)	140	Ulutu	WPM	277,946	9,354,055	ESTIMATED
MATONG	341	Matong	CIP	362,283	9,385,309	NMB_GPS
MATUPIT 1	324	Matupit 1	KOM	409,921	9,531,076	NMB_GPS
MATUPIT 2	716	Matupit 2	KOM	409,475	9,531,398	NMB_GPS
MATUPIT 3	461	Matupit 3	KOM	409,549	9,530,977	NMB_GPS
MATUPIT 4	99	Matupit 4	KOM	410,083	9,530,851	NMB_GPS
MAUNA	198	Mauna	WPM	312,229	9,353,827	OLD_GPS
MELETONG	362	Meletong	MEL	276,679	9,335,558	OLD_GPS
MENEBONBON	261	Menebonbon	BIT	427,289	9,511,922	OLD_GPS
MENSUAL	107	Lamarain	EPO	383,758	9,448,424	NMB_GPS
MERAI	309	Merai	SIN	426,529	9,469,907	NMB_GPS
MERIENGPUNA	33	Ulutu	WPM	275,810	9,353,509	ESTIMATED
MILE	568	Mile	CIP	320,429	9,410,491	OLD_GPS
MILIM SUB-DIST OFF	22	Milim	EPO	388,250	9,425,490	ESTIMATED
MILIM VLG	247	Milim	EPO	388,290	9,425,870	OLD_GPS
MININGA	331	Mininga	MEL	284,582	9,336,290	NMB_GPS
MISBEAL PLNTN	31	Kadaulung No.1	INB	402,957	9,503,607	NMB_GPS
MOBILIM	175	Mobilim	LAB	359,815	9,485,105	OLD_GPS
MOBISBERG PLNTN	39	Mobisberg	LAB	365,784	9,530,359	NMB_GPS
MOKEMOKE	23	Manigugule	CIP	335,276	9,436,784	OLD_GPS
MOLOT	463	Molot	DOY	439,456	9,543,699	OLD_GPS
MONGO	77	Gelioi	CIP	354,808	9,417,487	NMB_GPS
MORALONA (Gelioi)	121	Okempuna	WPM	286,292	9,369,208	ESTIMATED
MORELONA (Okempuna)	67	Kinsena	WPM	279,524	9,365,362	ESTIMATED
MSETWEI	321	Klampun	EPO	402,815	9,413,324	OLD_GPS
MU (WPM)	125	Pomai/Mu	WPM	324,502	9,369,486	ESTIMATED
MU VLG (EPO)	164	Milim	EPO	392,837	9,423,730	NMB_GPS
MUALIM	412	Mualim	DOY	440,384	9,533,632	NMB_GPS
MUELA	101	Muela	CIP	324,862	9,420,122	OLD_GPS
MUKULU	147	Mukulu	CIP	317,860	9,410,723	OLD_GPS
MUKUS	108	Raolman	MEL	285,552	9,338,901	ESTIMATED
MUMULOALA	53	Paliavulu	WPM	296,846	9,365,243	OLD_GPS
MUNGOU 1 BASE CAMP	79	Gar	SIN	430,157	9,481,447	OLD_GPS
MUREP	63	Warale	MEL	271,300	9,355,630	NMB_GPS
MURLEMI	124	Makmak	MEL	254,398	9,333,573	OLD_GPS
NABATA VLG	578	Nabata	LIR	397,682	9,534,460	OLD_GPS
NABUAL	468	Nabual	DOY	444,109	9,538,388	OLD_GPS
NAGAILA	360	Makada	DOY	434,434	9,545,589	NMB_GPS
NAKUKUR NO.1	911	Kumaina	DOY	435,141	9,539,989	OLD_GPS
NAMBUNG PLNTN	56	Traiwara	LAB	355,693	9,532,417	OLD_GPS
NANGAS	128	Nangas	LAB	352,852	9,534,162	NMB_GPS

NANUK	669	Nanuk	RAL	412,505	9,520,437	NMB_GPS
NAPAPAR NO.1 VLG	958	Napapar No.1	CGZ	402,314	9,520,729	OLD_GPS
NAPAPAR NO.2 VLG	1708	Napapar No.2	CGZ	402,066	9,520,253	OLD_GPS
NAPAPAR NO.3 VLG	922	Napapar No.3	CGZ	400,203	9,520,402	OLD_GPS
NAPAPAR NO.4 VLG	827	Napapar No.4	CGZ	399,336	9,519,147	OLD_GPS
NAPAPAR NO.5 VLG	1270	Napapar No.5	CGZ	397,489	9,518,793	OLD_GPS
NAVUI / MAMAPIT	546	Navui/Mamapit	LAB	368,082	9,533,025	OLD_GPS
NAVUNARAM VLG	1758	Navunaram	CGZ	403,222	9,525,142	OLD_GPS
NEINDUK PLNTN	105	Lassul	LAB	355,885	9,535,493	OLD_GPS
NENGMUTKA	127	Kadaulung No.1	INB	401,945	9,501,791	NMB_GPS
NEW CAMP	134	Rieit	SIN	398,174	9,495,217	NMB_GPS
NEW KAVERN PLNTN	120	Lassul	LAB	357,456	9,534,712	OLD_GPS
NEW MASSAWA PLNTN	161	Karo	LAB	367,496	9,533,100	ESTIMATED
NGATUR	530	Ngatur	RAL	409,998	9,519,354	OLD_GPS
NGAVAL	327	Parole	CIP	327,730	9,383,826	OLD_GPS
NGUNGUNA	691	Ngunguna	KOV	411,945	9,518,931	OLD_GPS
NGUVALIAN	54	Manapki	INB	389,129	9,512,596	NMB_GPS
NGUVALIAN	499	Nguvalian	RAL	409,534	9,523,409	OLD_GPS
NIUWOK PLNTN	89	Ulaveo	BIT	427,698	9,519,363	OLD_GPS
NODUP	180	Nodup	KOM	412,185	9,535,851	NMB_GPS
NONGA	967	Nonga	BAL	405,310	9,539,176	OLD_GPS
NONGA HOSPITAL	289	Nonga Base	BAL	405,681	9,540,218	NMB_GPS
NONGA RES. AREA	450	Nonga Base	BAL	405,440	9,539,420	ESTIMATED
NONGA STAFF RESIDENCE	176	Nonga Base	BAL	405,274	9,539,053	ESTIMATED
NONGIA COMM. SCH	20	Merai	SIN	425,345	9,466,444	NMB_GPS
NOTREMAL	194	Takis	LAB	344,131	9,535,634	OLD_GPS
NUKUMAL PLNTN	101	Sunam	SIN	409,214	9,506,814	NMB_GPS
OBSERVATORY	25	Rabaul Urban	RAB	406,346	9,536,457	ESTIMATED
OISCA COLLEGE	45	Wairiki No.3	TOM	411,976	9,508,545	IAS_GPS
OKEMPUNA	47	Okempuna	WPM	290,281	9,369,322	OLD_GPS
OLAIPUN	275	Olaipun	CIP	337,902	9,391,707	NMB_GPS
OPEN BAY TIMBERS	607	Open Bay Timbers	LAB	355,030	9,468,972	OLD_GPS
ORA	102	Gelioi	CIP	355,425	9,425,670	OLD_GPS
PAGE STREET	159	Rabaul Urban	RAB	409,000	9,535,761	ESTIMATED
PAGEPUNA	49	Galewa	CIP	331,225	9,389,650	ESTIMATED
PAGOU	45	Olaipun	CIP	338,209	9,391,876	NMB_GPS
PAINAWE (PUPALA)	145	Bago	CIP	325,015	9,428,079	OLD_GPS
PAKA	78	Paka	WPM	293,304	9,374,827	ESTIMATED
PAKIA	177	Pakia	CIP	322,299	9,408,406	NMB_GPS
PALAKAU PLNTN	93	Sunam	SIN	411,286	9,506,848	NMB_GPS
PALAVIRUA	138	Palavirua	KOV	414,063	9,509,339	OLD_GPS
PALIAVULU	121	Paliavulu	WPM	299,077	9,364,620	OLD_GPS
PALIPAL	277	Makada	DOY	436,108	9,544,779	NMB_GPS
PALMALMAL (TOWN) STN	558	Tolel	WPM	333,117	9,377,443	OLD_GPS
PALNAKAUR	512	Palnakaur	KOV	419,928	9,518,003	OLD_GPS
PALPAL	796	Palpal	DOY	439,729	9,532,335	NMB_GPS
PANARAPKA	83	Panarapka	LAB	339,125	9,513,943	NMB_GPS
PAPALABA VLG	347	Papalaba	TOM	404,821	9,511,529	OLD_GPS
PAPUN	54	Mainge	MEL	296,489	9,341,999	NMB_GPS
PARAKAMAN	243	Parakaman	CIP	351,789	9,409,029	OLD_GPS
PARK STREET	3	Rabaul Urban	RAB	409,000	9,534,299	ESTIMATED
PAROLE	279	Parole	CIP	327,830	9,383,629	OLD_GPS
PASINGPUN ES	53	Lamarain	EPO	383,562	9,448,086	ESTIMATED
PASISILONA	49	Olaipun	CIP	340,132	9,393,506	OLD_GPS
PASTORS COLL	263	Totovel	LIR	392,410	9,528,256	OLD_GPS
PATA	145	Bago	CIP	324,500	9,431,448	NMB_APPRX
PATURU	153	Parakaman	CIP	350,913	9,406,549	OLD_GPS
PAUOVE	83	Masuari	CIP	331,098	9,426,281	ESTIMATED
PAUOVE/SITORU	47	Marevu	CIP	331,900	9,424,542	OLD_GPS
PELING	177	Peling	WPM	286,662	9,365,300	OLD_GPS
PELLY	79	Marevu	CIP	329,306	9,422,139	OLD_GPS
PENDI	92	Lakiri	CIP	357,043	9,411,359	100K_TOPO
PENOI	92	Tokai	CIP	353,328	9,392,900	NMB_GPS
PEPENG	120	Pepeng	WPM	289,238	9,347,843	OLD_GPS
PHILLIPS STREET	88	Rabaul Urban	RAB	408,300	9,536,072	ESTIMATED
PIAVU	192	Birigi	CIP	349,105	9,413,630	ESTIMATED
PIGAPUNA	83	Parole	CIP	328,038	9,383,317	OLD_GPS
PIKUS CAMP	56	Lassul	LAB	359,318	9,531,640	OLD_GPS
PILAPILA	736	Pilapila	BAL	404,277	9,536,339	OLD_GPS
PILEMATANA	268	Pilematana	MEL	275,513	9,339,266	NMB_GPS
PIRI / SIMOGA	38	Totongpal	WPM	328,400	9,371,300	NMB_APPRX
PIRTOP	374	Butlivuan	DOY	442,100	9,541,250	ESTIMATED
PITA	51	Warale	MEL	268,115	9,358,763	NMB_GPS
PLONGEL	52	Lamarain	EPO	383,281	9,447,318	ESTIMATED
POIO	231	Poio	MEL	276,899	9,338,920	OLD_GPS
POKAPUNA	145	Pokapuna	WPM	292,533	9,372,815	NMB_GPS
POLPOLO	126	Ruachana	MEL	280,959	9,334,067	NMB_GPS
POMAI / MU	138	Pomai/Mu	WPM	322,523	9,369,732	OLD_GPS
POMIO	356	Pomio	CIP	335,748	9,389,394	NMB_GPS

POMIO COMM. SCH (BOKONGTATAR)	58	Pomio	CIP	336,203	9,389,380	OLD_GPS
POMIO HEALTH CTR	53	Pomio	CIP	335,150	9,389,758	NMB_GPS
PONDO PLNTN	43	Wiliambemki/Poinara	LAB	346,690	9,495,505	OLD_GPS
PONGAREVE	111	Masuari	CIP	328,738	9,424,932	ESTIMATED
PONGOLONA	23	Aona	WPM	284,906	9,365,597	OLD_GPS
POPOLAKAI	63	Warale	MEL	258,945	9,355,370	OLD_GPS
PORA (CIP)	62	Kawa	CIP	352,783	9,391,433	NMB_GPS
PORA (WPM)	86	Kinsena	WPM	280,020	9,368,444	NMB_GPS
PORLO	58	Lau	WPM	315,479	9,360,299	OLD_GPS
PORO	109	Poro/Salel	WPM	329,499	9,377,619	NMB_GPS
PUAPAL	217	Puapal	WPM	327,843	9,377,196	OLD_GPS
PUE/MALWEI	79	Matong	CIP	361,675	9,386,759	NMB_GPS
PUKTAS	127	Puktas	LAB	364,214	9,530,623	NMB_GPS
PULIPUNA	111	Kinsena	WPM	277,506	9,364,824	OLD_GPS
PULPUL	481	Pulpul	CIP	377,774	9,387,393	OLD_GPS
PUMA	84	Masuari	CIP	326,259	9,428,555	OLD_GPS
PURPUR	33	Olaipun	CIP	340,005	9,391,211	OLD_GPS
PUTANAGORORROI VLG	607	Putanagororoi	LIR	396,174	9,534,947	OLD_GPS
PUTPUT LOGGING	641		SIN	428,803	9,495,859	OLD_GPS
RABABAT	1008	Rababat	LIR	392,116	9,536,507	OLD_GPS
RABAGI NO.1	488	Rabagi No.1	TOM	405,464	9,516,402	OLD_GPS
RABAGI NO.2	802	Rabagi No.2	TOM	402,938	9,515,053	OLD_GPS
RABARUA	763	Rabarua	RAL	407,340	9,524,133	100K_TOPO
RABATA	277	Rabata	TOM	403,122	9,509,291	OLD_GPS
RABAUL 26	91	Rabaul Urban	RAB	407,600	9,535,911	ESTIMATED
RABAUL SHIPPING	264	Rabaul Urban	RAB	409,000	9,535,271	ESTIMATED
RABUANA	571	Rabuana	KOM	411,516	9,537,704	NMB_GPS
RABURBUR	732	Raburbur	LIR	401,831	9,529,088	OLD_GPS
RABURUA	181	Manapki	INB	389,275	9,514,431	ESTIMATED
RADAKADA	343	Radakada	LIR	398,257	9,531,735	NMB_GPS
RADINGI	375	Radingi	INB	372,207	9,522,880	OLD_GPS
RAGAGA	212	Ragaga	INB	370,280	9,528,075	NMB_GPS
RAGELO	158	Kalakuru	CIP	348,709	9,386,430	OLD_GPS
RAINAU	686	Rainau	BIT	426,361	9,515,103	NMB_GPS
RAINAU 1 PLNTN	233	Rainau	BIT	426,118	9,517,128	OLD_GPS
RAINUT	177	Kawa	CIP	353,488	9,390,335	NMB_GPS
RAKANDA PLNTN	271	Virian	DOY	441,235	9,535,948	NMB_GPS
RAKIVAL	296	Rakival	WAT	397,479	9,547,250	OLD_GPS
RAKOTOP	401	Rakotop	LIR	400,846	9,527,316	OLD_GPS
RAKUNAI VLG	1844	Rakunai	CGZ	402,780	9,527,400	OLD_GPS
RAKUNAT	195	Rakunat	KOM	410,615	9,536,548	NMB_GPS
RALALAR	584	Ralalar	RAL	408,118	9,522,161	OLD_GPS
RALUAN NO.1	380	Raluan No.1	BAL	403,916	9,531,222	100K_TOPO
RALUAN NO.2	581	Raluan No.2	BAL	403,554	9,529,580	100K_TOPO
RALUANA	913	Raluana	RAL	413,481	9,524,076	NMB_GPS
RALUANA NO. 3	535	Raluana No.3	LIR	395,269	9,533,054	OLD_GPS
RALUBANG	769	Ralubang	BIT	423,323	9,510,457	OLD_GPS
RALUBANG PLNTN	199	Katakatai	BIT	422,793	9,509,536	NMB_GPS
RAMALE (KOV)	484	Ramale	KOV	418,914	9,513,680	OLD_GPS
RAMALE (LIR)	625	Ramale	LIR	401,015	9,528,200	OLD_GPS
RAMALMAL	724	Ramalmal	LIR	400,606	9,532,974	OLD_GPS
RAMANDU PLNTN	66	Ragaga	INB	370,593	9,528,621	ESTIMATED
RAMANDU STLMNT	200	Ragaga	INB	372,495	9,530,967	NMB_GPS
RANGULIT	283	Rangulit	INB	381,833	9,513,326	OLD_GPS
RANGUNA	633	Ranguna	RAL	412,023	9,521,291	OLD_GPS
RANIOLO PLNTN	201	Kokopo Town	KOV	418,727	9,518,222	100K_TOPO
RAPITOK NO.1	637	Rapitok No.1	TOM	402,349	9,517,591	OLD_GPS
RAPITOK NO.2	301	Rapitok No.2	TOM	401,359	9,516,665	OLD_GPS
RAPITOK NO.3	1029	Rapitok No.3	TOM	400,412	9,515,115	OLD_GPS
RAPITOK NO.4	799	Rapitok No.4	TOM	402,438	9,515,708	OLD_GPS
RAPOLO	597	Rapolo	BAL	405,491	9,531,884	OLD_GPS
RAPOPO PLNTN	144	Vunapope	KOV	423,753	9,520,435	OLD_GPS
RARONGO THEOL. COLL	451	Totovel	LIR	392,692	9,528,606	NMB_GPS
RATAVUL (BAL)	790	Ratuval	BAL	404,777	9,537,275	OLD_GPS
RATAVUL (BIT)	415	Ratavul	BIT	422,340	9,511,159	NMB_GPS
RATAVUL 1 (TOM)	611	Ratavul	TOM	404,205	9,519,697	OLD_GPS
RATAVUL 2 (TOM)	368	Ratavul	TOM	403,682	9,519,379	OLD_GPS
RATONGOR VLG	1171	Ratongor	LIR	394,103	9,535,723	OLD_GPS
RATUNG	635	Ratung	BAL	403,997	9,535,753	OLD_GPS
RAU	529	Taranata/Rau	WAT	396,733	9,545,331	OLD_GPS
RAULAVAT PLNTN	270	Tavilo stlmnt	CGZ	392,813	9,526,100	OLD_GPS
RAUNSEPNA	1087	Raunsepna	INB	365,131	9,507,339	OLD_GPS
RAVAL VOC CTR	44	Radakada	LIR	397,156	9,532,421	NMB_GPS
RAVAT	853	Ravat	RAL	409,146	9,519,040	OLD_GPS
REIGAL	112	Reigal	SIN	406,685	9,483,150	NMB_GPS
RELINGPUNA	79	Ulutu	WPM	280,328	9,355,653	OLD_GPS
RHUNAGI	564	Rhungagi	INB	397,508	9,507,005	100K_TOPO
RICE CAMP	69	Matanakunai	LAB	354,358	9,464,772	NMB_GPS
RIEIT	311	Rieit	SIN	400,465	9,496,080	OLD_GPS

RIEIT BLOCKS	373	Rieit	SIN	401,719	9,497,449	NMB_APPRX
ROLANGI	41	Olaipun	CIP	337,314	9,393,951	NMB_GPS
ROLPUN	58	Tokai	CIP	357,389	9,390,408	NMB_GPS
ROVAN / MALO	117	Rowan/Malo	WPM	322,441	9,374,263	NMB_GPS
ROWAN	86	Rowan/Malo	WPM	324,810	9,371,197	OLD_GPS
RUACHANA	225	Ruachana	MEL	278,822	9,334,045	NMB_GPS
RUGEN HARBOUR COMM. SCH	25		SIN	428,381	9,494,526	NMB_GPS
RUM JUNGLE PLNTN	144	Sunam	SIN	404,685	9,501,056	OLD_GPS
RUNG CREEK	76	Sunam	SIN	401,988	9,500,966	OLD_GPS
RURAI	177	Kerkernena	CIP	327,182	9,385,096	ESTIMATED
SAHALIL	78	Raolman	MEL	287,630	9,339,788	NMB_GPS
SAI FORESTRY	50	Matanakunai	LAB	357,292	9,458,361	NMB_GPS
SALEL	102	Poro/Salel	WPM	329,722	9,377,535	NMB_GPS
SALI	298	Sali	CIP	339,542	9,388,421	NMB_GPS
SAMOA STREET	54	Rabaul Urban	RAB	409,000	9,534,402	ESTIMATED
SAMPUN VLG	219	Sampun	EPO	403,951	9,408,274	NMB_GPS
SANBAM	307	Sandam	SIN	414,564	9,492,945	NMB_GPS
SANGOMALE	146	Mukulu	CIP	315,804	9,411,367	OLD_GPS
SANIPUNA (Okempuna)	73	Okempuna	WPM	292,982	9,371,218	OLD_GPS
SANIPUNA (Viosopuna)	122	Viosopuna	WPM	292,633	9,370,047	OLD_GPS
SARANGAS PLNTN	9	Gar	SIN	430,049	9,478,642	OLD_GPS
SECTION 100	7	Rabaul Urban	RAB	407,600	9,535,795	ESTIMATED
SECTION 103/118/119/126	33	Rabaul Urban	RAB	407,000	9,535,745	ESTIMATED
SECTION 63	159	Rabaul Urban	RAB	409,000	9,535,155	ESTIMATED
SECTION 68	62	Rabaul Urban	RAB	408,300	9,535,736	ESTIMATED
SELEPLEPUN	65	Pulpul	CIP	379,247	9,389,574	NMB_APPRX
SENMAGI STLMNT	118	Awungi	INB	396,542	9,504,865	NMB_GPS
SEREGI LOGGING	143	Morokindam	LAB	335,597	9,525,923	OLD_GPS
SERENGUNA	103	Serenguna	WPM	302,859	9,365,025	OLD_GPS
SIKUT STLMNT	558	Sunam	SIN	414,909	9,502,969	NMB_GPS
SIKUT-MATUPIT SETLMT	928	Matupit 5	KOM	411,847	9,501,601	NMB_GPS
SIKUT-TALVAT STLMNT	815	-	-	411,280	9,499,904	NMB_GPS
SIMI	273	Simi	MEL	259,942	9,338,745	OLD_GPS
SIPALNGAN	41	Lamarain	EPO	383,252	9,446,064	NMB_APPRX
SIUKENA	46	Tolel	WPM	334,645	9,376,945	NMB_GPS
SIVAONA	318	Sivaona	WPM	289,217	9,351,796	NMB_GPS
SMALL VUDAL	217	Manapki	INB	389,420	9,516,566	OLD_GPS
SONOMA SDA COLL	330	Palavirua	KOV	415,611	9,510,642	OLD_GPS
STOCKHOLM PLNTN	145	Watmetki	LAB	337,156	9,519,246	OLD_GPS
STREET 1	1	Rabaul Urban	RAB	407,000	9,535,963	ESTIMATED
SUMHUNA	173	Raolman	MEL	281,688	9,345,917	OLD_GPS
SUMSUM PLNTN	68	Merai	SIN	429,577	9,474,857	OLD_GPS
SUNAM	672	Sunam	SIN	406,370	9,504,428	OLD_GPS
SUNNY BIRD	262	Napapar No.1	CGZ	403,664	9,521,521	OLD_GPS
TABUNA	320	Tabuna	BIT	420,918	9,511,473	OLD_GPS
TABUNA PLNTN	206	Tabuna	BIT	420,900	9,511,100	ESTIMATED
TAGITAGI NO.1	1116	Tagitagi No.1	TOM	407,539	9,517,091	OLD_GPS
TAGITAGI NO.2	524	Tagitagi No.2	TOM	409,169	9,513,360	OLD_GPS
TAGUL VLG	70	Sampun	EPO	404,187	9,409,686	NMB_GPS
TAKEKEL VLG	1405	Takelel	CGZ	403,358	9,522,199	OLD_GPS
TAKIS	345	Takis	LAB	333,708	9,534,756	OLD_GPS
TAKUBAR	252	Takubar	KOV	421,736	9,519,964	NMB_GPS
TAKUBAR ESTATE	150	Kokopo Town	KOV	421,300	9,519,580	ESTIMATED
TAKUBAR INDUSTRIAL AREA	285	Kokopo Town	KOV	422,070	9,519,836	ESTIMATED
TAKUBAR PLNTN	148	Takubar	KOV	421,626	9,519,597	OLD_GPS
TALAKUA	285	Talakua	RAL	406,044	9,522,717	100K_TOPO
TALAKUA PLNTN	248	Talakua	CGZ	405,832	9,521,952	100K_TOPO
TALIE	186	Malmal	WPM	330,791	9,377,569	OLD_GPS
TALILIS PLNTN	45	Lat	SIN	430,467	9,488,321	NMB_GPS
TALIVE	48	Muela	CIP	325,586	9,421,024	OLD_GPS
TAMANAIRIK NO.1	734	Tamanairik No.1	TOM	406,675	9,514,820	OLD_GPS
TAMANAIRIK NO.2	287	Tamanairik No.2	TOM	404,346	9,513,943	OLD_GPS
TANAKA	698	Tanaka	TOM	407,598	9,519,183	OLD_GPS
TANGAUN	147	Raolman	MEL	285,577	9,343,646	ESTIMATED
TANGOLO COMM. SCH	14	Makmak	MEL	258,454	9,336,277	NMB_SCH
TANUA PLNTN	41	Londip	BIT	422,074	9,506,222	OLD_GPS
TARANATA	144	Taranata/Rau	WAT	396,438	9,547,721	OLD_GPS
TARANGA	547	Taranga	LIR	401,172	9,531,037	OLD_GPS
TAUI NO.1	1001	Taui No.1	BIT	424,889	9,516,013	NMB_GPS
TAUI NO.2	1058	Taui No.2	BIT	424,372	9,514,335	NMB_GPS
TAULIL NO.1	1077	Taulil No.1	TOM	399,272	9,512,126	OLD_GPS
TAULIL NO.2	719	Taulil No.2	TOM	398,743	9,511,392	OLD_GPS
TAVANA	160	Tavana	BAL	405,958	9,528,674	OLD_GPS
TAVILO PLNTN	797	Tavilo stlmnt	CGZ	390,865	9,525,152	NMB_GPS
TAVILO STLMNT	466	Tavilo stlmnt	CGZ	392,544	9,524,278	NMB_GPS
TAVOLO	97	Tavolo	MEL	268,002	9,335,214	OLD_GPS
TAVUI NO.1	1362	Tavui No.1	BAL	406,384	9,541,791	OLD_GPS
TAVUI NO.2	572	Tavui No.2	BAL	408,010	9,541,557	OLD_GPS
TAVUI NO.3	365	Tavui No.3	BAL	408,409	9,540,562	OLD_GPS

TAVUILIU VLG	1052	Tavuiliu	CGZ	404,421	9,526,262	OLD_GPS
TEIMTOP	88	Waswas	EPO	402,364	9,406,240	NMB_GPS
TETAL	131	Parakaman	CIP	348,805	9,408,598	OLD_GPS
TEVI	66	Makmak	MEL	256,536	9,335,826	NMB_GPS
TI	32	Yauyau	WPM	277,595	9,374,329	NMB_GPS
TINGANAGALIP	1105	Tinganagalip	CGZ	402,738	9,523,845	OLD_GPS
TINGANALOM	1051	Tinganalom	RAL	410,695	9,520,666	OLD_GPS
TINGANAVUDU	667	Tinganavudu	KOV	413,868	9,516,746	OLD_GPS
TOBERA NO.1	89	Gunanur	KOV	416,919	9,512,486	NMB_GPS
TOBERA NO.2 PLNTN	106	Londip	BIT	418,943	9,510,539	OLD_GPS
TOBOINA VLG	535	Tomboina	LIR	395,966	9,531,795	OLD_GPS
TOBURUTUE PLNTN	242	Malakuna	BIT	428,834	9,517,961	NMB_GPS
TOGORO	426	Togoro	BIT	423,633	9,512,652	NMB_GPS
TOGUATA POLICE BARRACKS	497	Bitakapuk No.1	TOM	410,367	9,516,301	IAS_GPS
TOKAI	49	Tokai	CIP	358,300	9,390,630	OLD_GPS
TOKIALA PLNTN	198	Tavilo stlmnt	CGZ	393,401	9,523,662	OLD_GPS
TOKOTA STLMT	251	Bitakapuk No.1	TOM	408,604	9,516,337	NMB_APPRX
TOKUA AIRPORT	107	Ulaveo	BIT	430,827	9,519,839	OLD_GPS
TOKUA PLNTN	233	Ulaveo	BIT	428,691	9,520,267	OLD_GPS
TOLEL	108	Tolel	WPM	318,766	9,379,020	OLD_GPS
TOMARINGA POLICE STN	314	Takelel	CGZ	403,364	9,523,147	OLD_GPS
TORIU PLNTN	32	Mobilim	LAB	354,131	9,479,153	OLD_GPS
TOTONGPAL	180	Totongpal	WPM	330,247	9,371,352	NMB_GPS
TOTOVEL VLG	907	Totovel	LIR	398,988	9,530,274	OLD_GPS
TOUALEKA	902	Toualeka	LIR	400,376	9,529,494	OLD_GPS
TOVANUKAS PLNTN	66	Nangas	LAB	352,106	9,535,182	NMB_GPS
TOVURU PLNTN	161	Ulaveo	BIT	431,423	9,520,642	NMB_GPS
TOWNSEND STREET	202	Rabaul Urban	RAB	409,000	9,534,667	ESTIMATED
TRAIWARA	252	Traiwara	LAB	355,780	9,530,219	OLD_GPS
TUKE NO.1	158	Tuke	CIP	331,403	9,420,897	OLD_GPS
TUKE NO.2	87	Tuke	CIP	332,150	9,421,348	OLD_GPS
TUNA PUNA PLNTN	109	Sunam	SIN	404,615	9,500,382	OLD_GPS
TUNNEL HILL	222	Rabaul Urban	RAB	406,557	9,536,133	ESTIMATED
TURAGUNAN	375	Turagunan	RAL	408,506	9,521,149	OLD_GPS
TUREVUT PAKIA/SAELPUN	40	Matong	CIP	360,117	9,408,172	NMB_GPS
UGA	51	Raolman	MEL	285,024	9,342,165	OLD_GPS
ULAGUNAN	961	Ulagunan	KOV	416,528	9,516,554	OLD_GPS
ULAK	96	Lamarainam	INB	384,672	9,515,193	NMB_GPS
ULAMATIS (MATUPIT 5 RSTLMNT)	167	Ulagunan	KOV	416,500	9,518,450	ESTIMATED
ULATAVA	140	Palavirua	KOV	414,200	9,513,957	OLD_GPS
ULAULATAVA	854	Ulaulatava	KOV	413,139	9,516,250	OLD_GPS
ULAVEO PLNTN 1	314	Ulaveo	BIT	426,156	9,519,978	NMB_GPS
ULAVEO PLNTN 2	305	Ulaveo	BIT	427,073	9,520,043	NMB_GPS
ULO	56	Serenguna	WPM	309,261	9,358,277	ESTIMATED
ULU PLNTN	172	Utuan	DOY	436,535	9,533,751	NMB_GPS
ULUTU	91	Ulutu	WPM	279,300	9,352,762	ESTIMATED
UNITED BUILDING COM. PLNTN	23	Rieit	SIN	403,204	9,500,174	OLD_GPS
UNUNG PLNTN	11	Gugulena	WPM	329,251	9,378,643	OLD_GPS
URAI	81	Merai	SIN	424,731	9,471,045	100K_TOPO
URAKUKUR	337	Urakukur	DOY	439,007	9,542,425	OLD_GPS
URKUK	244	Molot	DOY	438,938	9,544,211	OLD_GPS
USEWIT PLNTN	53	Takis	LAB	343,687	9,533,990	100K_TOPO
USUVIT	217	Liaga	INB	393,036	9,510,194	NMB_GPS
UTMEI HIGH SCH	48	Lamarainam	INB	381,493	9,516,933	NMB_GPS
UTUAN NO.1	491	Utuan	DOY	438,389	9,532,470	NMB_GPS
UVOL	264	Uvol	MEL	277,320	9,335,355	OLD_GPS
UVOL CATH. MISS	21	Ruachana	MEL	278,871	9,334,681	OLD_GPS
UVOL SUB-DIST OFF	51	Uvol	MEL	276,799	9,336,389	NMB_GPS
UVOL VOC. CTR	53	Ruachana	MEL	277,300	9,335,800	ESTIMATED
VALAUR (BAL)	269	Valaur	BAL	405,960	9,529,630	NMB_GPS
VALAUR (WAT)	338	Valaur	WAT	395,321	9,545,723	NMB_GPS
VALILAI	123	Lamarainam	INB	380,367	9,518,427	NMB_APPRX
VARENULA PLNTN	59	Londip	BIT	422,953	9,504,296	OLD_GPS
VESTER STREET	120	Rabaul Urban	RAB	407,000	9,536,055	ESTIMATED
VIMMY PLNTN	399	Londip	BIT	420,299	9,509,648	ESTIMATED
VIOSOPUNA	68	Viosopuna	WPM	292,891	9,369,144	OLD_GPS
VIRIAN	504	Virian	DOY	440,444	9,532,611	NMB_GPS
VITAVUN PLNTN	11	Rieit	SIN	402,390	9,499,217	OLD_GPS
VIVIRAN	727	Viviran	TOM	407,223	9,511,716	OLD_GPS
VIVIRAN NO.2	396	Viviran No.2	TOM	405,851	9,509,742	OLD_GPS
VOLAVOLA VLG	1182	Volavolo	LIR	391,000	9,531,189	OLD_GPS
VOLAVOLO	1003	Volavolo	BAL	404,991	9,538,081	OLD_GPS
VUDAL STLMNT	1125	Vudal	INB	388,585	9,519,626	NMB_GPS
VUDAL TIMBERS	250	Tavilo stlmnt	CGZ	391,789	9,523,278	OLD_GPS
VUDAL UNIVERSITY	566	Vudal	INB	390,052	9,518,869	OLD_GPS
VUNABALBAL	714	Vunabalbal	KOV	414,848	9,518,915	OLD_GPS
VUNABAUR	435	Vunabaur	BIT	423,461	9,507,077	OLD_GPS
VUNABOSCO	61	Takubar	KOV	421,090	9,517,604	ESTIMATED
VUNABUK	327	Vunabuk	WAT	396,179	9,543,823	OLD_GPS

VUNABUKUBUK	81	Ramalmal	LIR	400,619	9,534,303	NMB_GPS
VUNADAVAI VLG	1102	Vunadavai	LIR	390,748	9,536,603	OLD_GPS
VUNADIDIR	800	Vunadidir	TOM	405,029	9,518,588	OLD_GPS
VUNADIDIR TRAINING CTR	73	Vunadidir	TOM	404,785	9,519,303	NMB_GPS
VUNAGOGO VLG	904	Vunagogo	CGZ	402,479	9,523,059	OLD_GPS
VUNAIROTO	1162	Vunairoto	LIR	399,306	9,535,789	OLD_GPS
VUNAITING	432	Vunaitung	LIR	399,308	9,533,261	OLD_GPS
VUNAKABAI	214	Vunakabai	WAT	398,272	9,543,882	OLD_GPS
VUNAKABI	498	Vunakabi	TOM	405,192	9,519,240	NMB_GPS
VUNAKAINALAMA	467	Vunakainalama	LIR	399,830	9,531,628	OLD_GPS
VUNAKALKALULU	655	Vunakalkalulu	LIR	401,618	9,530,857	OLD_GPS
VUNAKANAU PLNTN	73	Takelel	CGZ	397,416	9,522,134	NMB_GPS
VUNAKAUR	791	Vunakaur	TOM	405,676	9,512,998	OLD_GPS
VUNALAKA	758	Vunalaka	LIR	402,842	9,528,842	OLD_GPS
VUNALAMA PLNTN	173	Kamanakam	INB	370,453	9,525,306	ESTIMATED
VUNALAMA STLMNT	38	Kamanakam	INB	370,331	9,525,638	100K_TOPO
VUNALIR/VUNAMARITA	528	Vunalir	LIR	394,710	9,535,180	OLD_GPS
VUNAMAMI	2199	Vunamami	KOV	415,597	9,520,490	OLD_GPS
VUNAMURMUR	1141	Vunamurmur	RAL	410,681	9,523,142	OLD_GPS
VUNAPAKA	627	Vunapaka	LIR	398,106	9,530,549	OLD_GPS
VUNAPAKA HEALTH CTR	38	Vunapaka	LIR	398,106	9,530,400	ESTIMATED
VUNAPALADING GOVT STN	157	Vunapalading No.1	INB	385,670	9,515,890	ESTIMATED
VUNAPALADING NO.1	1016	Vunapalading No.1	INB	385,650	9,515,800	ESTIMATED
VUNAPALADING NO.2	452	Vunapalading No.2	INB	382,677	9,516,008	OLD_GPS
VUNAPAU CATH. MISSN	32	Vunapope	KOV	422,015	9,517,821	OLD_GPS
VUNAPEO	148	Matanakunai	LAB	355,155	9,463,256	ESTIMATED
VUNAPOPE	39	Kokopo Town	KOV	420,353	9,519,789	OLD_GPS
VUNAPOPE CATH MISSN	1075	Kokopo Town	KOV	421,130	9,519,692	ESTIMATED
VUNAPOPE MISSION WORKS	595	Kokopo Town	KOV	421,100	9,519,831	ESTIMATED
VUNARARERE	322	Vunarere	TOM	404,359	9,513,002	OLD_GPS
VUNATAGIA	515	Vunatagia	RAL	412,566	9,523,461	OLD_GPS
VUNAULAIAR	380	Vunaulaiar	WAT	397,269	9,544,461	OLD_GPS
VUNAULAITING	927	Vunaulaiting	LIR	398,993	9,529,085	OLD_GPS
VUNAULUL	719	Vunaulul	RAL	409,666	9,522,184	OLD_GPS
WAIPO	68	Waipo	MEL	246,434	9,340,269	OLD_GPS
WAIRA	255	Waira	DOY	443,645	9,540,522	OLD_GPS
WAIRIKI NO.1	804	Wairiki No.1	TOM	409,644	9,512,144	OLD_GPS
WAIRIKI NO.2	614	Wairiki No.2	TOM	409,371	9,511,390	OLD_GPS
WAIRIKI NO.3	773	Wairiki No.3	TOM	409,531	9,512,324	100K_TOPO
WAIRIKI NO.4	748	Wairiki No.4	TOM	408,462	9,510,852	OLD_GPS
WAIRIKI PLNTN	45	Wairiki No.3	TOM	411,804	9,512,192	NMB_GPS
WAIWARE STLMNT	261	Kadaulung No.2	INB	402,534	9,506,200	NMB_GPS
WALA	16	Waipo	MEL	247,022	9,340,630	OLD_GPS
WALIRUA	69	Sunam	SIN	417,325	9,505,187	NMB_APPRX
WANGA	52	Manginuna	WPM	335,209	9,373,131	NMB_GPS
WANGPUPUNA	133	Aona	WPM	284,074	9,365,546	OLD_GPS
WANLISS STREET	83	Rabaul Urban	RAB	409,000	9,534,901	ESTIMATED
WARAKINDAM	461	Warakindam	LAB	369,381	9,530,391	OLD_GPS
WARALE	64	Warale	MEL	270,535	9,356,257	100K_TOPO
WARANGOI BUFFALO STN	35	Sunam	SIN	410,489	9,504,902	OLD_GPS
WARANGOI HIGH SCH	110	Sunam	SIN	406,400	9,503,300	ESTIMATED
WARANGOI RESTLMNT (EX-LATLAT)	212	-	SIN	406,000	9,503,700	ESTIMATED
WARANGOI SAWMILL	242	Sunam	SIN	411,448	9,507,049	OLD_GPS
WARANGOI STLMNT	579	Sunam	SIN	407,154	9,506,000	ESTIMATED
WARANGOI STLMNT (CARE CTR)	52	Sunam	SIN	407,154	9,505,800	NMB_GPS
WARANGOI STN	387	Sunam	SIN	406,276	9,503,150	OLD_GPS
WARENA RESTLMNT (EX-LATLAT)	40	-	SIN	423,621	9,504,243	NMB_GPS
WARICK PLNTN	133	Sunam	SIN	405,783	9,502,276	OLD_GPS
WATA PLNTN	133	Ulaveo	BIT	433,365	9,521,523	NMB_GPS
WATARA	335	Waira	DOY	443,845	9,539,544	NMB_GPS
WATERSMEET PLNTN	104	Wairiki No.3	TOM	411,313	9,508,241	NMB_APPRX
WATMETKI	295	Watmetki	LAB	339,565	9,516,765	OLD_GPS
WATWAT	419	Watwat	BIT	425,446	9,505,700	OLD_GPS
WATWAT PLNTN	76	Londip	BIT	425,144	9,506,597	OLD_GPS
WAWAIS	188	Waswas	EPO	401,428	9,404,357	NMB_GPS
WELU	80	Warale	MEL	270,336	9,359,920	OLD_GPS
WIDE BAY LOGGING	49	Lamarain	EPO	387,721	9,450,310	ESTIMATED
WILD DOG	2	Rieit	SIN	393,969	9,488,993	NMB_GPS
WILIAMPEMAKI/POINIARA	507	Wiliambemki/Poinara	LAB	347,994	9,499,961	OLD_GPS
WILLTANE PLNTN	112	Kadaulung No.1	INB	403,598	9,503,641	NMB_GPS
WING MAU PLNTN	90	Sunam	SIN	406,465	9,503,870	OLD_GPS
WONDAROO	50	Palavirua	KOV	414,267	9,510,596	ESTIMATED
WONGAWONGA NO.1&2	142	Palavirua	KOV	413,204	9,512,121	OLD_GPS
WUATAM	324	Manapki	INB	386,730	9,515,692	NMB_GPS
YAKA TAVUSI	127	Kaikou	WPM	277,560	9,377,184	ESTIMATED
YALAM	265	Yalam	LAB	361,032	9,512,415	OLD_GPS
YAUYAU	162	Yauyau	WPM	274,010	9,377,601	OLD_GPS
YAYAMI	115	Yayami	INB	373,374	9,510,575	OLD_GPS
YELALONA LEMENA ("YLW LEMON"?)	74	Okempuna	WPM	288,896	9,370,858	NMB_GPS

Appendix 4. Geolocated 1980 census data.

East New Britain geo-located Census 1980 census unit population data

Filename: ENB_CENSUS_1980_WGS84Z56.TAB

Projection: WGS84 Zone 56 South

Source: Final figures: Census Unit Populations, East New Britain Province. National Statistical Office, Port Moresby, 1982; Provincial Data System Rural Community Register, East New Britain Province. National Statistical Office, Port Moresby, 1983.

Geolocated records: 671 ; Records unlocated: 10

Geolocated population = 132,690; Unlocated population = 507, Total population = 133,197 which is equal to the official tally.

The tabulated data here was compiled from the 1980 census unit populations for ENB, to which point coordinates were added from a number of sources. Most points are taken from National Mapping Bureau GPS data. Some census units have disappeared, so were located from the NSO 'rural community register' maps of 1983. Other maps were consulted for points still not located, mainly the 1:100,000 topographical maps from the 1970s. In a few cases locations were reasonably guessed. Ten records could not be located from maps nor reasonably guessed. These are listed in a tabulation at the end of the main tabulation. In some cases CU names were adjusted to accepted spellings, or to standardise or for clarification. Errors which may exist in the original census count are inherent and still remain. Some locational errors will still exist, but overall this dataset is reliable. Anomalies found in the source data are marked with an asterisk (*) after the CU name, as in the case of duplicate identical names in the same location.

Coding for geolocation quality (GEOQUAL): 100K_TOPO = location from 1:100,000 topographic maps published in 1970s; Estimated = location from informants or guessed from other information; LANDS_DIV = locations from Milinch maps; NMB_APPROX = National Mapping Bureau GPS point re-adjusted e.g. for match to coastline; NMB_GPS = National Mapping Bureau GPS point from c.1999; OLD_GPS = National Mapping Bureau point apparently older, perhaps c.1995; NSO1983 = 1980 census maps by National Statistical Office, 1983.

CU_NAME	TL_POP	CD_NAME	LON	LAT	GEOQUAL
ADMIN COMPOUND STLMNT	342	RABAUL URBAN	409,000	9,535,954	ESTIMATED
AINBUL	59	MELKOI	238,253	9,346,962	OLD_GPS
ALAKASAM	273	LASSUL BAINING	370,891	9,504,175	OLD_GPS
ARAMBUM	286	SINIVIT/EAST_BAINING	401,734	9,491,858	OLD_GPS
ASALINGI PLNTN	20	LASSUL BAINING	404,730	9,519,253	OLD_GPS
ATU	105	MELKOI	299,438	9,341,554	NMB_GPS
AU'UNA	299	WEST POMIO	282,755	9,365,146	NSO1983
AU'UNA HC	20	WEST POMIO	282,243	9,366,112	NSO1983
BAAI	435	KOMBIU	413,720	9,534,861	NMB_GPS
BAGATAVI	207	EAST POMIO	349,501	9,411,175	OLD_GPS
BAGO	162	CENTRAL POMIO	318,130	9,428,215	OLD_GPS
BAIEN (WEST)	99	CENTRAL POMIO	328,476	9,386,742	NSO1983
BAILU PLNTN	38	VUNAMAMI	413,143	9,513,418	OLD_GPS
BAIN EAST	174	EAST POMIO	399,169	9,400,621	NSO1983
BAIRAMAN	109	WEST POMIO	322,071	9,362,065	OLD_GPS
BAKURIA	270	EAST POMIO	350,242	9,413,314	OLD_GPS
BALADA	101	BITAPAKA	422,622	9,513,999	OLD_GPS
BALANATAMAN	295	RALUANA	413,510	9,521,310	OLD_GPS
BALIORA PLNTN	44	VUNAMAMI	410,453	9,516,790	NSO1983
BAROVON	306	RALUANA	412,388	9,524,909	OLD_GPS
BAU'OWE	64	EAST POMIO	326,629	9,427,039	NSO1983
BEREME	62	MELKOI	236,100	9,365,780	NMB_GPS
BILI	258	WEST POMIO	288,785	9,373,508	NMB_GPS
BILUR	95	BITAPAKA	428,221	9,511,588	OLD_GPS
BINDAPUNA	13	WEST POMIO	321,061	9,366,055	NSO1983
BIRAR	168	BITAPAKA	427,424	9,512,926	NMB_GPS
BITABAUR	282	RALUANA	411,788	9,522,781	OLD_GPS
BITAGALIP	169	VUNAMAMI	420,867	9,516,085	OLD_GPS
BITAKAPUK	698	TOMA	407,711	9,515,275	NSO1983
BITAPAKA	17	BITAPAKA	422,552	9,513,170	NMB_GPS
BITAPAKA WAR CEMETERY	29	BITAPAKA	422,259	9,512,942	OLD_GPS
BITAREBEREBE	558	VUNAMAMI	416,120	9,518,922	OLD_GPS
BITATITA	97	RALUANA	408,993	9,523,280	OLD_GPS
BOISEN HS	43	KOMBIU	411,558	9,536,807	NSO1983
BOKONGTATA	175	EAST POMIO	375,233	9,388,400	NMB_GPS
BOVALPUN	90	CENTRAL POMIO	345,659	9,385,476	OLD_GPS
BUBUANA PLNTN	23	SINIVIT/EAST_BAINING	404,029	9,499,412	NMB_GPS
BUKA	152	CENTRAL POMIO	365,835	9,384,431	NMB_GPS
BULOI	31	EAST POMIO	334,113	9,427,590	NSO1983
BUROWEI	38	MELKOI	252,659	9,337,916	OLD_GPS

BUTLIVUAN	259	DUKE OF YORK ISLANDS	442,179	9,541,177	OLD_GPS
BUTUWIN HC	66	VUNAMAMI	415,750	9,521,785	OLD_GPS
CHANEL COLLEGE	140	VUNAMAMI	423,099	9,520,064	NMB_GPS
CHIMBU STLMNT	233	RABAUL URBAN	409,100	9,533,900	ESTIMATED
CLIFTON PLNTN	65	VUNAMAMI	415,255	9,507,460	LANDS_DIV
DADUL	53	SINIVIT/EAST_BAINING	401,769	9,495,116	OLD_GPS
DAKA	126	EAST POMIO	328,466	9,422,923	NSO1983
DEEPDENE PLNTN	26	SINIVIT/EAST_BAINING	403,096	9,507,066	NMB_GPS
DELROY PLNTN	15	SINIVIT/EAST_BAINING	402,752	9,497,296	OLD_GPS
DRAIWARA	109	LASSUL BAINING	370,245	9,527,412	100KTOPO
DRINA PLNTN	32	WEST POMIO	325,285	9,368,840	OLD_GPS
FINSCHAFEN STLMNT	462	RABAUL URBAN	409,100	9,533,800	ESTIMATED
GAGALOWE	329	CENTRAL POMIO	331,639	9,389,486	NSO1983
GANAI	331	BITAPAKA	426,290	9,504,275	OLD_GPS
GAR	159	SINIVIT/EAST_BAINING	429,900	9,479,200	NSO1983/G
GAULIM	443	TOMA	399,509	9,509,412	OLD_GPS
GAULIM TEACHERS COLLEGE	245	TOMA	398,946	9,508,933	NMB_GPS
GAVIT PLNTN	110	LASSUL BAINING	349,156	9,535,270	ESTIMATED
GAZELLE TIMBERS	129	CENTRAL	391,142	9,523,503	NSO1983
GEORGE BROWN HS	450	CENTRAL	392,355	9,527,666	NMB_GPS
GILAGILA PLNTN	286	VUNAMAMI	416,162	9,513,140	ESTIMATED
GILALUM	77	BITAPAKA	421,925	9,508,297	OLD_GPS
GILIU	146	EAST POMIO	352,761	9,412,748	NSO1983
GIREGIRE PLNTN	148	VUNAMAMI	413,012	9,517,565	NSO1983
GUGULENA	186	WEST POMIO	328,672	9,377,790	OLD_GPS
GUMA	135	EAST POMIO	399,304	9,416,639	OLD_GPS
GUMA CATH MISSN	30	EAST POMIO	398,946	9,416,822	NSO1983
GUNANBA	545	VUNAMAMI	411,249	9,518,370	OLD_GPS
GUNANUR	270	TOMA	418,804	9,516,575	OLD_GPS
GUNANUR PLNTN	279	VUNAMAMI	418,350	9,514,900	LANDS_DIV
HAULO	177	MELKOI	283,479	9,339,762	NSO1983
HOIYA	174	EAST POMIO	383,206	9,431,973	NMB_GPS
IALAKUA	313	RALUANA	412,782	9,524,741	OLD_GPS
IAWAKAKA	540	BALANATAMAN	404,012	9,534,566	100K_TOPO
ILI	152	SINIVIT/EAST_BAINING	423,122	9,462,438	NMB_GPS
ILUGI PLNTN	32	SINIVIT/EAST_BAINING	402,782	9,498,097	OLD_GPS
INAHELE	172	MELKOI	277,625	9,335,363	NMB_GPS
INDUNA PLNTN	82	SINIVIT/EAST_BAINING	429,919	9,491,340	NMB_GPS
INLIMUT	161	DUKE OF YORK ISLANDS	441,990	9,538,990	NMB_GPS
INOLO	197	DUKE OF YORK ISLANDS	442,041	9,535,650	OLD_GPS
IRENA	325	CENTRAL POMIO	327,401	9,379,015	OLD_GPS
IVERE	171	TOMA	397,906	9,508,786	OLD_GPS
IWAI	296	EAST POMIO	396,877	9,419,663	NMB_GPS
KABABIAI	139	DUKE OF YORK ISLANDS	441,262	9,539,160	OLD_GPS
KABAIRA	70	LIVUAN	390,081	9,531,541	OLD_GPS
KABAKADA	304	LIVUAN	399,679	9,535,190	OLD_GPS
KABAKAUL	144	VUNAMAMI	425,012	9,519,518	NSO1983
KABAKAUL PLNTN 1	25	BITAPAKA	425,501	9,519,625	NSO1983
KABAKAUL PLNTN 2	43	BITAPAKA	425,207	9,519,062	NSO1983
KABALEO TEACHERS COLLEGE	241	VUNAMAMI	421,468	9,517,793	OLD_GPS
KABANGA PLNTN	147	BITAPAKA	428,550	9,510,050	NMB_GPS
KABATIRAI	168	DUKE OF YORK ISLANDS	441,287	9,534,806	OLD_GPS
KABILOMO	560	DUKE OF YORK ISLANDS	438,568	9,541,777	OLD_GPS
KADAULUNG 2	78	TOMA	402,190	9,507,785	NMB_GPS
KAIKOU	149	WEST POMIO	277,622	9,374,853	OLD_GPS
KAINAGUNAN	302	TOMA	397,728	9,507,287	OLD_GPS
KAITON	217	WEST POMIO	325,904	9,370,180	OLD_GPS
KAITOTO	221	WEST POMIO	289,806	9,365,557	OLD_GPS
KALAKRU	56	CENTRAL POMIO	347,942	9,385,730	NSO1983
KALAMPUN	313	EAST POMIO	401,023	9,414,880	OLD_GPS
KALIP	97	EAST POMIO	383,103	9,434,288	NMB_GPS
KAMAKAMAR	200	BITAPAKA	426,744	9,512,352	NMB_GPS
KAMANAKAM	290	LASSUL BAINING	371,708	9,522,018	ESTIMATED
KAMBABU HIGH SCH	465	SINIVIT/EAST_BAINING	429,514	9,493,888	NMB_GPS
KANGILONA	87	MELKOI	302,464	9,346,368	NMB_GPS
KANUNU	167	MELKOI	277,527	9,344,869	NSO1983
KARAVI	297	VUNAMAMI	414,650	9,521,422	OLD_GPS
KARAVIA (BAL)	280	BALANATAMAN	404,548	9,536,915	OLD_GPS
KARAVIA 1 (CGZ)	215	CENTRAL	406,350	9,525,786	OLD_GPS
KARAVIA 2 (CGZ)	214	CENTRAL	405,404	9,524,378	OLD_GPS
KAREEBA PLNTN	33	LASSUL BAINING	391,550	9,520,410	LANDS_DIV
KAREEBA STLMNT	95	LASSUL BAINING	392,756	9,517,950	NMB_GPS
KARLAI PLNTN/SPANGO CS	187	EAST POMIO	384,724	9,442,919	NMB_GPS
KARO	244	LASSUL BAINING	367,001	9,534,028	OLD_GPS
KARONG	189	SINIVIT/EAST_BAINING	414,256	9,451,644	OLD_GPS
KARU	125	BITAPAKA	429,355	9,512,869	OLD_GPS
KATAKATAI	293	BITAPAKA	420,502	9,512,864	OLD_GPS
KAUKUM	292	EAST POMIO	386,270	9,429,084	OLD_GPS
KAUWA	97	CENTRAL POMIO	353,826	9,390,823	NSO1983

KAVALI	62	EAST POMIO	354,321	9,410,392	NSO1983
KAVUDEMKI	112	EAST POMIO	384,802	9,455,151	NMB_GPS
KEMATANME	140	CENTRAL POMIO	320,190	9,427,770	NMB_GPS
KENMENINGA	267	MELKOI	280,086	9,347,917	OLD_GPS
KEREKEMBAK PLNTN	51	SINIVIT/EAST_BAINING	402,300	9,500,000	NMB_APPRX
KEREVAT 01	258	KEREVAT URBAN	393,639	9,519,204	NMB_GPS
KEREVAT 02	636	KEREVAT URBAN	394,200	9,518,813	NMB_GPS
KEREVAT CIS	490	LASSUL BAINING	394,761	9,511,199	OLD_GPS
KEREVAT L.A.E.S.	348	CENTRAL	392,372	9,521,088	OLD_GPS
KEREWARA	172	DUKE OF YORK ISLANDS	435,610	9,530,920	NMB_GPS
KERKERENA	91	CENTRAL POMIO	328,279	9,385,346	OLD_GPS
KIAGE	74	EAST POMIO	350,374	9,412,620	NSO1983
KIEP PLNTN	18	EAST POMIO	390,850	9,425,310	LANDS_DIV
KIKITABU	248	REIMBER	399,310	9,528,366	OLD_GPS
KILALUM	135	EAST POMIO	398,182	9,418,143	OLD_GPS
KILIGIA	29	SINIVIT/EAST_BAINING	407,803	9,489,560	NMB_GPS
KINSENA	244	WEST POMIO	280,574	9,364,158	OLD_GPS
KIRKIHAU	63	EAST POMIO	396,622	9,420,037	NSO1983
KLINWATA PLNTN	63	LASSUL BAINING	371,490	9,529,420	ESTIMATED
KOILAU	116	EAST POMIO	332,015	9,431,294	OLD_GPS
KOKOPO 01	94	KOKOPO URBAN	418,790	9,519,882	NMB_GPS
KOKOPO 02	186	KOKOPO URBAN	419,027	9,519,663	ESTIMATED
KOKOPO 03	184	KOKOPO URBAN	419,242	9,519,718	ESTIMATED
KOKOPO 04	132	KOKOPO URBAN	419,423	9,519,840	ESTIMATED
KOKOPO 601	85	KOKOPO URBAN	418,808	9,519,800	ESTIMATED
KOKOPO 602	926	KOKOPO URBAN	418,808	9,519,750	ESTIMATED
KOKOPO 603	372	KOKOPO URBAN	418,808	9,519,700	ESTIMATED
KOKOPO 604	132	KOKOPO URBAN	418,808	9,519,650	ESTIMATED
KOLOM	103	EAST POMIO	399,551	9,416,281	NSO1983
KOLOPOM STLMNT	114	LASSUL BAINING	354,763	9,532,613	OLD_GPS
KOMGI	238	LASSUL BAINING	359,740	9,516,390	NMB_GPS
KORAI (BIT)	175	BITAPAKA	426,340	9,512,052	OLD_GPS
KORAI (EPO)	64	EAST POMIO	351,679	9,410,360	NSO1983
KORATUL	102	MELKOI	284,870	9,341,216	NSO1983
KORERE	551	BALANATAMAN	410,380	9,539,686	NSO1983
KORI NO.2 STLMNT	140	RABAUL URBAN	409,100	9,533,700	ESTIMATED
KORPUN	102	EAST POMIO	392,885	9,396,526	OLD_GPS
KORT STLMNT	106	RABAUL URBAN	409,100	9,533,600	ESTIMATED
KUKULU	81	WEST POMIO	278,508	9,375,677	NMB_GPS
KULA	39	EAST POMIO	351,734	9,411,578	OLD_GPS
KULON (*)	94	BITAPAKA	430,514	9,514,238	OLD_GPS
KULON (*)	176	BITAPAKA	430,514	9,514,238	OLD_GPS
KUMAINA	132	DUKE OF YORK ISLANDS	437,442	9,538,333	OLD_GPS
KUMLOKOR	180	DUKE OF YORK ISLANDS	441,187	9,538,350	NSO1983
KUNAKUNAI	453	RALUANA	409,205	9,520,092	NSO1983
KUNDIAWA STLMNT	125	RABAUL URBAN	409,100	9,533,500	ESTIMATED
KUPGEN	229	EAST POMIO	333,273	9,424,136	NSO1983
KURAIP	529	REIMBER	403,066	9,531,633	OLD_GPS
KURAKAKAUL STN	68	REIMBER	402,630	9,534,500	NMB_GPS
KUTAP PLNTN	13	CENTRAL POMIO	348,450	9,386,260	LANDS_DIV
LAKIRI	243	EAST POMIO	356,156	9,412,559	OLD_GPS
LAKUNDA PLNTN	35	VUNAMAMI	415,954	9,509,864	NMB_GPS
LALIKA	106	EAST POMIO	353,343	9,414,785	OLD_GPS
LAMALAMPUN	59	CENTRAL POMIO	357,303	9,390,381	NSO1983
LAMERAIN (EPO)	152	EAST POMIO	384,119	9,448,969	NMB_GPS
LAMERAIN (INB)	307	LASSUL BAINING	365,888	9,505,425	OLD_GPS
LANDKON COMM SCH	4	LASSUL BAINING	359,788	9,531,513	NSO1983
LASSUL 1&2	88	LASSUL BAINING	358,770	9,533,564	OLD_GPS
LASSUL PLNTN	47	LASSUL BAINING	357,440	9,533,670	NMB_GPS
LASSUL SDO	41	LASSUL BAINING	357,502	9,533,233	OLD_GPS
LAT	121	SINIVIT/EAST_BAINING	431,005	9,483,251	NMB_GPS
LATLAT	265	CENTRAL	403,970	9,527,450	NMB_GPS
LAUN	212	LASSUL BAINING	361,330	9,530,694	OLD_GPS
LAUP PLNTN (*)	15	SINIVIT/EAST_BAINING	407,375	9,505,860	OLD_GPS
LAUP PLNTN (*)	94	WEST POMIO	407,375	9,505,860	OLD_GPS
LAUSIS	231	MELKOI	273,183	9,338,130	OLD_GPS
LAVUGI	91	WEST POMIO	274,880	9,376,067	OLD_GPS
LEKIMPUNA	126	WEST POMIO	286,289	9,352,877	OLD_GPS
LELI	89	CENTRAL POMIO	322,180	9,422,644	OLD_GPS
LEMENGI	136	SINIVIT/EAST_BAINING	406,690	9,483,150	NMB_GPS
LILA	59	WEST POMIO	292,338	9,353,581	OLD_GPS
LININAKAIA PLNTN	38	LASSUL BAINING	350,841	9,534,704	ESTIMATED
LIVUAN (KOV)	305	VUNAMAMI	423,221	9,516,707	NMB_GPS
LIVUAN (RAL)	331	RALUANA	408,991	9,522,181	NMB_GPS
LOMELETENA	129	WEST POMIO	293,724	9,355,882	NSO1983
LONDIP	226	BITAPAKA	426,937	9,506,605	OLD_GPS
LONG PLNTN (*)	109	EAST POMIO	383,763	9,439,803	NSO1983
LOPUN	61	MELKOI	245,874	9,342,274	OLD_GPS
LUGE	123	WEST POMIO	280,368	9,370,318	NSO1983

LUNGALUNGA	343	LIVUAN	387,190	9,534,318	OLD_GPS
MAIHUNA	15	MELKOI	292,044	9,340,756	NMB_GPS
MAILIVUAN	174	LIVUAN	389,108	9,532,047	OLD_GPS
MAITO	303	WEST POMIO	307,156	9,366,092	OLD_GPS
MAKURAPAU	368	BITAPAKA	428,975	9,513,897	OLD_GPS
MAKURAPAU PLNTN	146	BITAPAKA	427,451	9,513,801	OLD_GPS
MALABUNGA	322	TOMA	399,449	9,512,118	NSO1983
MALABUNGA H.S.	507	TOMA	400,060	9,514,220	NMB_GPS
MALAGUNA 1	786	BALANATAMAN	406,512	9,535,151	OLD_GPS
MALAGUNA 2	454	BALANATAMAN	406,251	9,534,131	OLD_GPS
MALAGUNA 3	466	BALANATAMAN	405,561	9,532,961	OLD_GPS
MALAGUNA CATH CHURCH	20	BALANATAMAN	406,231	9,534,699	ESTIMATED
MALAGUNA FERMENTARY	40	BALANATAMAN	406,166	9,534,424	ESTIMATED
MALAKUNA (BIT)	339	BITAPAKA	429,020	9,515,899	NMB_GPS
MALAKUNA (VUN)	426	VUNAMAMI	412,144	9,513,941	NSO1983
MALAKUR	133	CENTRAL POMIO	327,627	9,384,451	OLD_GPS
MALASAIT	556	LASSUL BAINING	376,871	9,506,462	OLD_GPS
MALAYTOWN STLMNT	920	RABAUL URBAN	409,100	9,533,400	ESTIMATED
MALBONE	220	CENTRAL POMIO	325,649	9,417,474	OLD_GPS
MALELE-JUMLA	60	MELKOI	241,397	9,363,879	NSO1983
MALMAL	48	WEST POMIO	329,961	9,377,585	OLD_GPS
MALMAL CATH MISSN	16	WEST POMIO	330,200	9,377,700	ESTIMATED
MALMALU	323	WEST POMIO	290,768	9,351,449	NSO1983
MALMALUAN	382	CENTRAL	404,957	9,525,042	OLD_GPS
MANDARAMBIT	131	LASSUL BAINING	362,109	9,476,895	OLD_GPS
MANDRESS PLNTN	64	LASSUL BAINING	375,961	9,523,145	OLD_GPS
MANDRESS STLMNT	110	LASSUL BAINING	379,689	9,520,100	ESTIMATED
MANGINUNA	143	WEST POMIO	335,344	9,373,832	OLD_GPS
MANIMBU PLNTN	19	LASSUL BAINING	335,213	9,524,314	NMB_APPRX
MANINGUGULE	71	EAST POMIO	330,846	9,430,016	NSO1983
MANSIPANA	59	EAST POMIO	325,599	9,425,755	OLD_GPS
MANTANAKUNAI COMM SCH	16	LASSUL BAINING	354,032	9,462,566	NSO1983
MANU	155	CENTRAL POMIO	320,274	9,430,456	NSO1983
MANUAN PLNTN	54	DUKE OF YORK ISLANDS	437,800	9,541,420	NMB_GPS
MAPRIK STLMNT	160	RABAUL URBAN	409,100	9,533,300	ESTIMATED
MAPUNA	157	WEST POMIO	287,617	9,363,545	OLD_GPS
MARA	36	CENTRAL POMIO	325,225	9,378,088	NMB_APPRX
MARAMBA PLNTN	10	SINIVIT/EAST_BAINING	426,600	9,498,460	LANDS_DIV
MARAMBU	123	SINIVIT/EAST_BAINING	418,280	9,487,340	NMB_GPS
MARANAGI	93	SINIVIT/EAST_BAINING	404,893	9,484,764	OLD_GPS
MARAWA	96	BITAPAKA	425,784	9,508,497	OLD_GPS
MAREN	303	DUKE OF YORK ISLANDS	440,537	9,543,255	OLD_GPS
MARIVU	97	EAST POMIO	328,693	9,421,912	OLD_GPS
MARMAR (BIT)	186	BITAPAKA	334,087	9,389,737	OLD_GPS
MARMAR (CIP)	240	CENTRAL POMIO	426,839	9,509,321	OLD_GPS
MARMAR (MEL)	101	MELKOI	252,733	9,331,673	NSO1983
MARTIN PLNTN	23	CENTRAL	394,787	9,523,072	NMB_GPS
MARUNGA	310	EAST POMIO	393,958	9,450,532	OLD_GPS
MARUNGA HC	2	EAST POMIO	394,200	9,450,400	ESTIMATED
MASKIKILIE	77	EAST POMIO	386,912	9,392,622	OLD_GPS
MASO	355	MELKOI	284,645	9,337,440	OLD_GPS
MASUARI	117	EAST POMIO	329,327	9,427,343	OLD_GPS
MATALA PLNTN	51	SINIVIT/EAST_BAINING	428,702	9,495,320	NMB_GPS
MATALAU	698	KOMBIU	411,770	9,536,355	NMB_GPS
MATANAKUNAI	183	LASSUL BAINING	354,247	9,462,173	OLD_GPS
MATANATAVA CATH MISSN	21	VUNAMAMI	423,600	9,519,550	NMB_GPS
MATAWAN	229	WEST POMIO	280,368	9,352,643	NMB_APPRX
MATONG	228	CENTRAL POMIO	362,283	9,385,309	NMB_GPS
MATUPIT 1	771	KOMBIU	409,921	9,531,076	NMB_GPS
MATUPIT 2	586	KOMBIU	409,475	9,531,398	NMB_GPS
MATUPIT 3	659	KOMBIU	409,549	9,530,977	NMB_GPS
MATUPIT FARM STLMNT	178	RABAUL URBAN	409,100	9,533,200	ESTIMATED
MAU'UNA	78	WEST POMIO	311,976	9,353,949	NMB_APPRX
MEINGI	184	MELKOI	293,848	9,342,368	NSO1983
MELETON	172	MELKOI	276,671	9,335,653	OLD_GPS
MENEBONBON	138	BITAPAKA	427,289	9,511,922	OLD_GPS
MENINGA	208	MELKOI	284,306	9,336,263	NMB_GPS
MERAI	343	SINIVIT/EAST_BAINING	426,529	9,469,907	NMB_GPS
MILAMILA COMM SCH	40	DUKE OF YORK ISLANDS	441,235	9,535,950	NMB_GPS
MILE	341	CENTRAL POMIO	320,429	9,410,491	OLD_GPS
MILIM	172	EAST POMIO	388,100	9,425,869	OLD_GPS
MILIM SDO	9	EAST POMIO	388,250	9,425,490	ESTIMATED
MIOKO (DOY)	207	DUKE OF YORK ISLANDS	439,730	9,532,420	NSO1983
MISBEAL PLNTN	13	SINIVIT/EAST_BAINING	402,957	9,503,607	NMB_GPS
MOKEIMOKEI	63	EAST POMIO	335,276	9,436,784	OLD_GPS
MOLOT	265	DUKE OF YORK ISLANDS	439,456	9,543,699	OLD_GPS
MONGU	52	EAST POMIO	352,666	9,413,607	NSO1983
MORALONA	106	WEST POMIO	279,856	9,364,976	NSO1983
MOROBE STLMNT	204	RABAUL URBAN	409,100	9,533,100	ESTIMATED

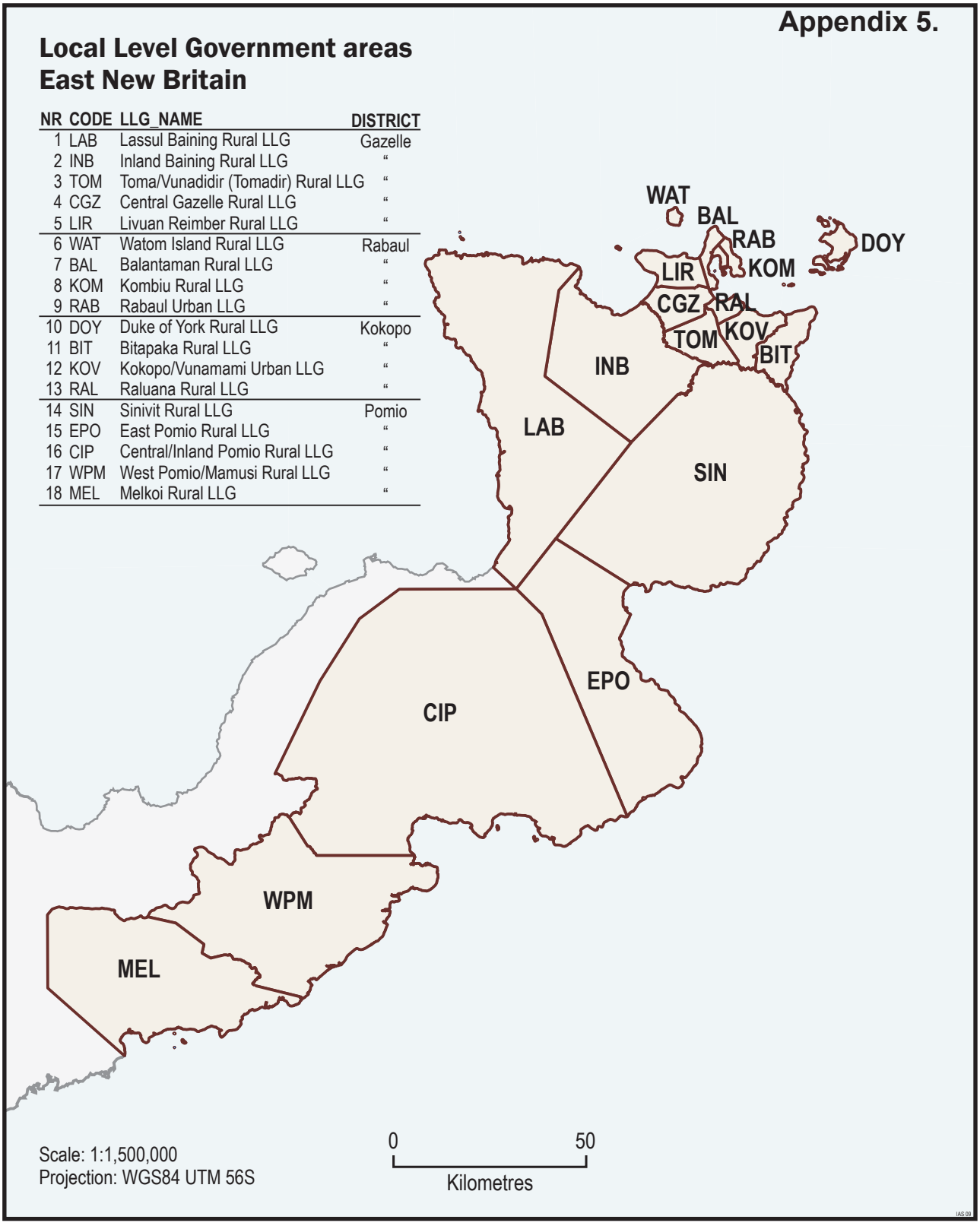
MSETWI	201	EAST POMIO	402,582	9,413,034	OLD_GPS
MU	116	EAST POMIO	393,026	9,422,838	NSO1983
MUALIM	276	DUKE OF YORK ISLANDS	440,480	9,533,520	NMB_GPS
MUELA	166	CENTRAL POMIO	324,862	9,420,122	OLD_GPS
MUKULU	126	CENTRAL POMIO	317,860	9,410,723	OLD_GPS
MYUNA PLNTN	20	VUNAMAMI	412,100	9,510,960	LANDS_DIV
NABATA	165	LIVUAN	397,682	9,534,460	OLD_GPS
NABUAL	282	DUKE OF YORK ISLANDS	444,064	9,538,338	OLD_GPS
NAGALIA	188	DUKE OF YORK ISLANDS	434,495	9,545,516	NMB_GPS
NAGWNAUA PLNTN	30	LASSUL BAINING	341,408	9,534,426	NSO1983
NAKUKUR 1	246	DUKE OF YORK ISLANDS	435,141	9,539,989	OLD_GPS
NAKUKUR 2	318	DUKE OF YORK ISLANDS	434,930	9,539,830	NMB_GPS
NAMBUNG PLNTN	84	LASSUL BAINING	355,693	9,532,417	OLD_GPS
NAMKUM PLNTN	145	BITAPAKA	427,070	9,520,040	NMB_GPS
NANGAS	92	LASSUL BAINING	352,852	9,534,162	NMB_GPS
NANUK	351	RALUANA	412,505	9,520,437	NMB_GPS
NAPAPAR 1	457	CENTRAL	402,314	9,520,729	OLD_GPS
NAPAPAR 2	408	CENTRAL	402,066	9,520,253	OLD_GPS
NAPAPAR 3	355	CENTRAL	400,203	9,520,402	OLD_GPS
NAPAPAR 4	426	CENTRAL	399,336	9,519,147	OLD_GPS
NAPAPAR 5	362	CENTRAL	397,489	9,518,793	OLD_GPS
NAROKOI	90	DUKE OF YORK ISLANDS	434,220	9,545,230	NMB_GPS
NATAVA PLNTN	110	LIVUAN	388,300	9,536,060	LANDS_DIV
NAVUI STLMNT	39	LASSUL BAINING	368,082	9,533,025	OLD_GPS
NAVUNARAM	575	CENTRAL	403,222	9,525,142	OLD_GPS
NAVUVU PLNTN	36	CENTRAL	393,398	9,521,473	NSO1983
NB QUARRIES STLMNT	310	RABAUL URBAN	409,100	9,533,000	ESTIMATED
NEINDUK PLNTN	93	LASSUL BAINING	355,894	9,535,330	OLD_GPS
NEW KAUERN PLNTN	47	LASSUL BAINING	357,320	9,534,708	OLD_GPS
NEW MASSAWA PLNTN	65	LASSUL BAINING	367,496	9,533,100	ESTIMATED
NGATUR	595	RALUANA	409,998	9,519,354	OLD_GPS
NGAVAL	196	CENTRAL POMIO	327,511	9,383,881	OLD_GPS
NGUNGUNA	458	VUNAMAMI	411,945	9,518,931	OLD_GPS
NGUVALIAN	309	RALUANA	389,129	9,512,596	NMB_GPS
NODUP	529	KOMBIU	412,128	9,535,827	NMB_GPS
NONGA	479	BALANATAMAN	405,310	9,539,176	OLD_GPS
NONGA BASE HOSPITAL	1051	BALANATAMAN	405,681	9,540,218	NMB_GPS
NONGA FERMENTARY	53	BALANATAMAN	405,472	9,539,804	NSO1983
NONGA SAWMILL	260	BALANATAMAN	405,066	9,538,966	NSO1983
NONGA STLMNT	111	BALANATAMAN	405,440	9,539,420	ESTIMATED
NONGIA C.S.	4	SINIVIT/EAST_BAINING	425,345	9,466,444	NMB_GPS
NOTEREMAL PLNTN	55	LASSUL BAINING	344,091	9,535,355	OLD_GPS
NUKUMAL PLNTN	46	SINIVIT/EAST_BAINING	409,214	9,506,814	NMB_GPS
NUTUVE CATH MISSN	20	EAST POMIO	351,775	9,409,915	NSO1983
NUWOK PLNTN	91	BITAPAKA	428,269	9,519,343	NSO1983
OKIMPUNA	288	WEST POMIO	290,281	9,369,322	OLD_GPS
OLAIPUN	283	CENTRAL POMIO	337,902	9,391,707	NMB_GPS
OPEN BAY POLICE STN	17	LASSUL BAINING	355,028	9,469,445	NSO1983
OPEN BAY TIMBERS	349	LASSUL BAINING	355,030	9,468,972	OLD_GPS
ORA	98	EAST POMIO	355,425	9,425,670	OLD_GPS
OTTLEY TIMBER	62	LASSUL BAINING	354,767	9,470,275	NSO1983
PAKA	204	WEST POMIO	293,304	9,374,827	ESTIMATED
PAKIA	377	CENTRAL POMIO	322,299	9,408,406	NMB_GPS
PALAKAUA PLNTN	28	SINIVIT/EAST_BAINING	411,286	9,506,848	NMB_GPS
PALIAVALU	174	WEST POMIO	299,077	9,364,620	OLD_GPS
PALMALMAL TOWN	393	WEST POMIO	333,111	9,377,389	OLD_GPS
PALPAL (*)	106	DUKE OF YORK ISLANDS	439,590	9,532,140	NMB_GPS
PALPAL (*)	276	DUKE OF YORK ISLANDS	439,590	9,532,090	NMB_GPS
PARAKAMAN	55	EAST POMIO	351,789	9,409,029	OLD_GPS
PAROL	154	CENTRAL POMIO	327,581	9,383,544	OLD_GPS
PATURU	89	EAST POMIO	350,913	9,406,549	OLD_GPS
PELIN	146	WEST POMIO	286,662	9,365,300	OLD_GPS
PELLAVARUA PLNTN	84	VUNAMAMI	414,060	9,509,340	NMB_GPS
PENOI	31	EAST POMIO	354,066	9,411,092	NSO1983
PENOI	44	CENTRAL POMIO	352,581	9,391,091	NSO1983
PEPING	156	WEST POMIO	289,238	9,347,843	OLD_GPS
PIAVU	104	EAST POMIO	349,105	9,413,630	ESTIMATED
PIKAPUNA	49	CENTRAL POMIO	327,744	9,383,218	OLD_GPS
PILAPILA	550	BALANATAMAN	404,277	9,536,339	OLD_GPS
PILIMATANA	270	MELKOI	275,513	9,339,266	NMB_GPS
PILPULO	143	MELKOI	282,250	9,335,840	NSO1983
PIOVE	123	EAST POMIO	352,180	9,412,020	NMB_GPS
PIRTOP	235	DUKE OF YORK ISLANDS	442,038	9,541,293	ESTIMATED
POGOVE	40	CENTRAL POMIO	356,337	9,390,521	NSO1983
POIO	220	MELKOI	276,899	9,338,920	OLD_GPS
POKAPUNA	193	WEST POMIO	292,533	9,372,815	NMB_GPS
POMAN	32	EAST POMIO	373,641	9,388,366	NSO1983
POME	138	WEST POMIO	322,595	9,369,352	NSO1983
POMIO	229	CENTRAL POMIO	335,209	9,389,777	NSO1983

POMIO TOWN	102	CENTRAL POMIO	335,748	9,389,394	NMB_GPS
PONDO PLNTN	82	LASSUL BAINING	346,690	9,495,505	OLD_GPS
PONGAREVE	200	EAST POMIO	328,738	9,424,932	ESTIMATED
PONGOLA	103	CENTRAL POMIO	356,826	9,390,486	NSO1983
PORA	81	CENTRAL POMIO	352,783	9,391,433	NMB_GPS
PORLO	32	WEST POMIO	315,479	9,360,299	OLD_GPS
PUAPAL	147	WEST POMIO	327,843	9,377,196	OLD_GPS
PUKTAS	153	LASSUL BAINING	364,214	9,530,623	NMB_GPS
PULEPUNA	213	WEST POMIO	277,506	9,364,824	OLD_GPS
PULPUL	147	EAST POMIO	377,774	9,387,393	OLD_GPS
PUNARUPKA/WILMITKI	254	LASSUL BAINING	339,839	9,514,710	NSO1983
PUNUM	94	MELKOI	288,978	9,342,638	NSO1983
PUTANAGORORO I	208	LIVUAN	396,174	9,534,947	OLD_GPS
PUTPUT LOGGING	74	SINIVIT/EAST_BAINING	428,711	9,495,819	OLD_GPS
PUTPUT PLNTN	133	SINIVIT/EAST_BAINING	427,710	9,497,690	NMB_GPS
RABAGI 1	318	TOMA	405,464	9,516,402	OLD_GPS
RABAGI 2	422	TOMA	402,938	9,515,053	OLD_GPS
RABATA	151	TOMA	403,122	9,509,291	OLD_GPS
RABAUL 01	345	RABAUL URBAN	407,000	9,537,500	ESTIMATED
RABAUL 02	222	RABAUL URBAN	407,000	9,537,400	ESTIMATED
RABAUL 03	547	RABAUL URBAN	407,000	9,537,300	ESTIMATED
RABAUL 04	167	RABAUL URBAN	407,000	9,537,200	ESTIMATED
RABAUL 05	124	RABAUL URBAN	407,000	9,537,100	ESTIMATED
RABAUL 06	102	RABAUL URBAN	407,000	9,537,000	ESTIMATED
RABAUL 07	144	RABAUL URBAN	407,000	9,536,900	ESTIMATED
RABAUL 08	62	RABAUL URBAN	407,000	9,536,800	ESTIMATED
RABAUL 09	106	RABAUL URBAN	407,000	9,536,700	ESTIMATED
RABAUL 10	123	RABAUL URBAN	407,000	9,536,600	ESTIMATED
RABAUL 11	165	RABAUL URBAN	407,000	9,536,500	ESTIMATED
RABAUL 12	483	RABAUL URBAN	407,000	9,536,400	ESTIMATED
RABAUL 13	175	RABAUL URBAN	407,000	9,536,300	ESTIMATED
RABAUL 14	115	RABAUL URBAN	407,000	9,536,200	ESTIMATED
RABAUL 15	132	RABAUL URBAN	407,000	9,536,100	ESTIMATED
RABAUL 16	190	RABAUL URBAN	407,000	9,536,000	ESTIMATED
RABAUL 17	301	RABAUL URBAN	407,000	9,535,900	ESTIMATED
RABAUL 18	186	RABAUL URBAN	407,000	9,535,800	ESTIMATED
RABAUL 19	211	RABAUL URBAN	407,000	9,535,700	ESTIMATED
RABAUL 20	231	RABAUL URBAN	407,600	9,537,600	ESTIMATED
RABAUL 21	459	RABAUL URBAN	407,600	9,537,500	ESTIMATED
RABAUL 22	269	RABAUL URBAN	407,600	9,537,400	ESTIMATED
RABAUL 23	238	RABAUL URBAN	407,600	9,537,300	ESTIMATED
RABAUL 24	338	RABAUL URBAN	407,600	9,537,200	ESTIMATED
RABAUL 25	138	RABAUL URBAN	407,600	9,537,100	ESTIMATED
RABAUL 26	266	RABAUL URBAN	407,600	9,537,000	ESTIMATED
RABAUL 27	113	RABAUL URBAN	407,600	9,536,900	ESTIMATED
RABAUL 28	187	RABAUL URBAN	407,600	9,536,800	ESTIMATED
RABAUL 29	210	RABAUL URBAN	407,600	9,536,700	ESTIMATED
RABAUL 30	149	RABAUL URBAN	407,600	9,536,600	ESTIMATED
RABAUL 31	235	RABAUL URBAN	407,600	9,536,500	ESTIMATED
RABAUL 32	130	RABAUL URBAN	407,600	9,536,400	ESTIMATED
RABAUL 33	151	RABAUL URBAN	407,600	9,536,300	ESTIMATED
RABAUL 34	139	RABAUL URBAN	407,600	9,536,200	ESTIMATED
RABAUL 35	188	RABAUL URBAN	407,600	9,536,100	ESTIMATED
RABAUL 36	264	RABAUL URBAN	407,600	9,536,000	ESTIMATED
RABAUL 37	235	RABAUL URBAN	407,600	9,535,900	ESTIMATED
RABAUL 38	165	RABAUL URBAN	407,600	9,535,800	ESTIMATED
RABAUL 39	151	RABAUL URBAN	407,600	9,535,700	ESTIMATED
RABAUL 40	195	RABAUL URBAN	408,200	9,537,600	ESTIMATED
RABAUL 41	338	RABAUL URBAN	408,200	9,537,500	ESTIMATED
RABAUL 42	174	RABAUL URBAN	408,200	9,537,400	ESTIMATED
RABAUL 43	281	RABAUL URBAN	408,200	9,537,300	ESTIMATED
RABAUL 44	103	RABAUL URBAN	408,200	9,537,200	ESTIMATED
RABAUL 45	104	RABAUL URBAN	408,200	9,537,100	ESTIMATED
RABAUL 46	251	RABAUL URBAN	408,200	9,537,000	ESTIMATED
RABAUL 47	241	RABAUL URBAN	408,200	9,536,900	ESTIMATED
RABAUL 48	117	RABAUL URBAN	408,200	9,536,800	ESTIMATED
RABAUL 49	40	RABAUL URBAN	408,200	9,536,700	ESTIMATED
RABAUL 50	219	RABAUL URBAN	408,200	9,536,600	ESTIMATED
RABAUL 51	266	RABAUL URBAN	408,200	9,536,500	ESTIMATED
RABAUL 52	92	RABAUL URBAN	408,200	9,536,400	ESTIMATED
RABAUL 53	95	RABAUL URBAN	408,200	9,536,300	ESTIMATED
RABAUL 54	205	RABAUL URBAN	408,200	9,536,200	ESTIMATED
RABAUL 55	141	RABAUL URBAN	408,200	9,536,100	ESTIMATED
RABAUL 56	101	RABAUL URBAN	408,200	9,536,000	ESTIMATED
RABAUL 57	210	RABAUL URBAN	408,200	9,535,900	ESTIMATED
RABUANA	388	KOMBIU	411,302	9,537,717	NMB_GPS
RABURBUR	260	REIMBER	401,831	9,529,088	OLD_GPS
RABURUA	247	RALUANA	389,275	9,514,431	ESTIMATED
RAIM	211	TOMA	405,930	9,520,530	NMB_GPS

RAINAU	362	BITAPAKA	426,361	9,515,103	NMB_GPS
RAINAU NO.1 PLNTN	12	BITAPAKA	426,118	9,517,128	OLD_GPS
RAINAU NO.2 PLNTN	247	BITAPAKA	426,220	9,516,480	NMB_GPS
RAKANDA PLNTN	119	DUKE OF YORK ISLANDS	441,126	9,535,960	NMB_GPS
RAKANDAKANDA	213	CENTRAL	401,362	9,526,233	NSO1983
RAKIVAL	213	WATOM ISLAND	397,479	9,547,250	OLD_GPS
RAKOTOP	188	REIMBER	400,846	9,527,316	OLD_GPS
RAKUMKUMBUR	252	LIVUAN	397,200	9,532,761	NSO1983
RAKUNAI	681	CENTRAL	402,780	9,527,400	OLD_GPS
RAKUNUT	303	KOMBIU	410,615	9,536,548	NMB_GPS
RALALAR	253	RALUANA	408,118	9,522,161	OLD_GPS
RALIMUT	522	REIMBER	400,113	9,530,415	NSO1983
RALMAN	106	EAST POMIO	394,904	9,398,011	NSO1983
RALUAN 1	204	REIMBER	403,916	9,531,222	100K_TOPO
RALUAN 2	279	REIMBER	403,554	9,529,580	100K_TOPO
RALUAN 3	281	LIVUAN	395,072	9,532,914	NSO1983
RALUANA	326	RALUANA	413,365	9,523,987	NMB_GPS
RALUBANG	425	BITAPAKA	423,323	9,510,457	OLD_GPS
RALUBANG PLNTN	164	BITAPAKA	422,793	9,509,536	NMB_GPS
RAMALE (RBR)	273	REIMBER	401,015	9,528,200	OLD_GPS
RAMALE (VUN)	283	VUNAMAMI	418,914	9,513,680	OLD_GPS
RAMALMAL	247	REIMBER	400,606	9,532,974	OLD_GPS
RAMANDU PLNTN	52	LASSUL BAINING	370,593	9,528,621	ESTIMATED
RAMBABAT	493	LIVUAN	392,116	9,536,507	OLD_GPS
RAMIDAL/VUNABAL	63	BITAPAKA	424,701	9,506,682	NSO1983
RANGARERE PLNTN	46	LASSUL BAINING	340,100	9,534,660	LANDS_DIV
RANGULIT	209	LASSUL BAINING	381,833	9,513,326	OLD_GPS
RANGUNA	222	RALUANA	412,023	9,521,291	OLD_GPS
RAPINDIK STLMNT	116	RABAUL URBAN	409,100	9,532,900	ESTIMATED
RAPITOK 1	325	TOMA	402,349	9,517,591	OLD_GPS
RAPITOK 2	155	TOMA	401,359	9,516,665	OLD_GPS
RAPITOK 3	421	TOMA	400,412	9,515,115	OLD_GPS
RAPITOK 4	377	TOMA	402,438	9,515,708	OLD_GPS
RAPOLO	356	REIMBER	405,491	9,531,884	OLD_GPS
RAPOPO PLNTN	113	VUNAMAMI	423,753	9,520,435	OLD_GPS
RAPUTPUT/MAKADA PLNTN	19	DUKE OF YORK ISLANDS	436,450	9,543,610	LANDS_DIV
RARONGO THEOL. COLL.	207	CENTRAL	392,692	9,528,606	NMB_GPS
RASIMEN	159	LIVUAN	391,040	9,531,315	NSO1983
RATAVUL (BAL)	434	BALANATAMAN	404,777	9,537,275	OLD_GPS
RATAVUL (BIT)	183	BITAPAKA	422,340	9,511,159	NMB_GPS
RATAVUL (TOM)	267	TOMA	404,205	9,519,697	OLD_GPS
RATONGOR	567	LIVUAN	394,103	9,535,723	OLD_GPS
RATUNG	426	BALANATAMAN	396,733	9,545,331	OLD_GPS
RAULAVAI PLNTN	111	CENTRAL	392,813	9,526,100	OLD_GPS
RAULILI	145	MELKOI	287,461	9,341,058	NSO1983
RAUNSEPNA	484	LASSUL BAINING	365,131	9,507,339	OLD_GPS
RAVAL VOC	108	LIVUAN	397,156	9,532,421	NMB_GPS
REIVEN PLNTN	154	BITAPAKA	431,863	9,517,395	NSO1983
RIET	180	SINIVIT/EAST_BAINING	400,465	9,496,080	OLD_GPS
ROWAN	125	WEST POMIO	324,810	9,371,197	OLD_GPS
RUAHUNA	127	MELKOI	278,869	9,334,039	NMB_GPS
RUGEN HARBOUR C.S.	64	SINIVIT/EAST_BAINING	428,181	9,494,455	NMB_GPS
RUM JUNGLE PLNTN	110	SINIVIT/EAST_BAINING	404,685	9,501,056	OLD_GPS
RUNG CREEK PLNTN	39	SINIVIT/EAST_BAINING	401,988	9,500,966	OLD_GPS
RURAI	114	CENTRAL POMIO	327,182	9,385,096	ESTIMATED
SAHALIL	132	MELKOI	287,685	9,339,811	NMB_GPS
SALI	135	CENTRAL POMIO	339,542	9,388,421	NMB_GPS
SAMPUN	143	EAST POMIO	403,649	9,408,371	NMB_GPS
SANGAMALI	116	CENTRAL POMIO	315,804	9,411,367	OLD_GPS
SANIPUNA	100	WEST POMIO	292,630	9,370,050	NMB_GPS
SARANGES PLNTN	12	SINIVIT/EAST_BAINING	430,075	9,478,566	OLD_GPS
SENEL	92	EAST POMIO	351,710	9,408,340	NMB_GPS
SEPIK STLMNT	53	RABAUL URBAN	409,103	9,532,800	ESTIMATED
SERENGUNA	290	WEST POMIO	302,859	9,365,025	OLD_GPS
SIKUTE STLMNT	28	SINIVIT/EAST_BAINING	414,909	9,502,969	NMB_GPS
SIMBUM	120	SINIVIT/EAST_BAINING	408,721	9,494,713	NSO1983
SIMI	212	MELKOI	259,942	9,338,745	OLD_GPS
SITORU	45	EAST POMIO	328,326	9,423,809	NSO1983
SIWOIRE	50	EAST POMIO	327,813	9,428,430	NSO1983
SONOMA PLNTN	51	VUNAMAMI	416,072	9,510,339	ESTIMATED
SONOMA SDA	364	VUNAMAMI	415,611	9,510,642	OLD_GPS
SOUTH COAST LOGGING	23	SINIVIT/EAST_BAINING	430,160	9,481,440	ESTIMATED
ST MARYS VUVU	337	BALANATAMAN	403,718	9,534,372	NSO1983
STOCKHOLM PLNTN	21	LASSUL BAINING	337,444	9,519,150	OLD_GPS
SUMSUM PLNTN	30	SINIVIT/EAST_BAINING	429,473	9,474,818	OLD_GPS
SUNAM	61	SINIVIT/EAST_BAINING	406,370	9,504,428	OLD_GPS
TABUNA	171	BITAPAKA	420,918	9,511,473	OLD_GPS
TABUNA PLNTN	126	BITAPAKA	420,900	9,511,100	ESTIMATED
TAGITAGI 1	438	TOMA	407,539	9,517,091	OLD_GPS

TAGITAGI 2	343	TOMA	409,169	9,513,360	OLD_GPS
TAGUL	96	EAST POMIO	403,816	9,409,644	NMB_GPS
TAINTOP	109	EAST POMIO	402,364	9,406,240	NMB_GPS
TAKELEL	381	CENTRAL	403,358	9,522,199	OLD_GPS
TAKIS	192	LASSUL BAINING	333,706	9,534,534	OLD_GPS
TAKIS REPEATER STN	5	LASSUL BAINING	334,828	9,535,332	NSO1983
TAKUBAR (TOM)	399	TOMA	404,280	9,510,610	NMB_GPS
TAKUBAR (VUN)	295	VUNAMAMI	421,754	9,519,736	NMB_APPRX
TAKUBAR PLNTN	56	KOKOPO URBAN	421,626	9,519,597	OLD_GPS
TALAKUA	236	CENTRAL	406,044	9,522,717	100K_TOPO
TALALO	55	WEST POMIO	279,629	9,366,510	NSO1983
TALIE	117	WEST POMIO	330,791	9,377,569	OLD_GPS
TALIS PLNTN	74	SINIVIT/EAST_BAINING	430,467	9,488,321	NMB_GPS
TALIVE	139	CENTRAL POMIO	325,586	9,421,024	OLD_GPS
TALWAT	540	KOMBIU	413,955	9,530,170	NSO1983
TAMALILI PLNTN	96	BITAPAKA	430,950	9,516,810	LANDS_DIV
TAMANAIRIK	411	TOMA	406,010	9,514,807	NSO1983
TANAKA	304	TOMA	407,598	9,519,183	OLD_GPS
TANUA PLNTN	51	BITAPAKA	422,074	9,506,222	OLD_GPS
TAPO CATH MISSN	25	BITAPAKA	423,056	9,512,671	NSO1983
TARANATA	212	WATOM ISLAND	396,374	9,547,443	NSO1983
TARANGA	289	REIMBER	401,172	9,531,037	OLD_GPS
TATOKO	156	REIMBER	400,960	9,532,250	NSO1983
TAUI 1	425	BITAPAKA	424,889	9,516,013	NMB_GPS
TAUI 2	462	BITAPAKA	424,372	9,514,335	NMB_GPS
TAULIL	754	TOMA	398,931	9,513,499	NSO1983
TAVALO	183	MELKOI	268,002	9,335,214	OLD_GPS
TAVANA-VALAUR	332	CENTRAL	405,958	9,528,674	OLD_GPS
TAVILO PLNTN	153	CENTRAL	390,865	9,525,152	NMB_GPS
TAVILO STLMNT	110	CENTRAL	392,544	9,524,278	NMB_GPS
TAVUI 1	518	BALANATAMAN	406,384	9,541,791	OLD_GPS
TAVUI 2	265	BALANATAMAN	408,010	9,541,557	OLD_GPS
TAVUI 3	282	BALANATAMAN	408,409	9,540,562	OLD_GPS
TAVUILIU	553	CENTRAL	404,420	9,526,260	NSO1983
TEITAUL ("TEA-TOWEL"?)	145	EAST POMIO	348,805	9,408,598	OLD_GPS
TI	23	WEST POMIO	277,595	9,374,329	NMB_GPS
TINGANAGALIP	611	CENTRAL	402,738	9,523,845	OLD_GPS
TINGANALOM	558	RALUANA	410,695	9,520,666	OLD_GPS
TINGENAVUDU	324	VUNAMAMI	413,868	9,516,746	OLD_GPS
TNT FLATS	82	BALANATAMAN	406,400	9,534,900	ESTIMATED
TOBERA NO.2	80	BITAPAKA	418,943	9,510,539	OLD_GPS
TOBERA PLNTN	110	VUNAMAMI	416,919	9,512,486	NMB_GPS
TOBOINA	222	LIVUAN	395,966	9,531,795	OLD_GPS
TOBURUTUE STLMNT	46	BITAPAKA	428,834	9,517,961	NMB_GPS
TOGORO	254	BITAPAKA	423,633	9,512,652	NMB_GPS
TOKAI-RAM	111	CENTRAL POMIO	358,200	9,390,210	NMB_GPS
TOKARKAR PLNTN	42	BITAPAKA	430,379	9,519,281	NSO1983
TOKOTA PLNTN	50	VUNAMAMI	409,627	9,516,784	NSO1983
TOKUA PLNTN	260	BITAPAKA	428,691	9,520,267	OLD_GPS
TOL PLNTN	88	EAST POMIO	389,715	9,449,160	NSO1983
TOLUVIA FERMENTARY	81	BALANATAMAN	403,613	9,535,393	NSO1983
TOMARINGA POLICE DEPOT	217	CENTRAL	403,364	9,523,147	OLD_GPS
TORAVILEI	137	EAST POMIO	350,820	9,409,915	NSO1983
TORIU PLNTN	69	LASSUL BAINING	354,131	9,479,153	OLD_GPS
TOTONGPAL	124	WEST POMIO	330,247	9,371,352	NMB_GPS
TOTOVEL COMM SCH	442	REIMBER	398,990	9,530,275	NMB_GPS
TOVANAKUS PLNTN	7	LASSUL BAINING	352,106	9,535,182	NMB_GPS
TOVARUR PLNTN	103	BITAPAKA	431,650	9,521,010	LANDS_DIV
TUKE 1	80	EAST POMIO	331,403	9,420,897	OLD_GPS
TUKE 2	185	EAST POMIO	332,150	9,421,348	OLD_GPS
TUNAPUNA PLNTN	22	SINIVIT/EAST_BAINING	404,615	9,500,382	OLD_GPS
TURAGUNAN	195	RALUANA	408,506	9,521,149	OLD_GPS
U.B.C. PLNTN	18	SINIVIT/EAST_BAINING	403,200	9,500,170	OLD_GPS
UGA	130	MELKOI	285,024	9,342,165	OLD_GPS
ULAGUNAN	391	VUNAMAMI	416,528	9,516,554	OLD_GPS
ULAGUNAN H.S.	410	VUNAMAMI	416,530	9,516,550	NMB_GPS
ULAKAI PLNTN	11	VUNAMAMI	409,996	9,516,697	NSO1983
ULATAWA PLNTN	76	VUNAMAMI	413,600	9,513,960	LANDS_DIV
ULAULATANA PLNTN	273	VUNAMAMI	413,139	9,516,250	OLD_GPS
ULAVEO PLNTN	106	BITAPAKA	426,160	9,519,980	NMB_GPS
ULU PLNTN	157	DUKE OF YORK ISLANDS	436,410	9,533,220	NMB_GPS
ULUTU	79	WEST POMIO	279,300	9,352,762	ESTIMATED
UNUNG PLNTN	7	WEST POMIO	329,118	9,378,677	OLD_GPS
URAKUKAR	219	DUKE OF YORK ISLANDS	439,007	9,542,425	OLD_GPS
URUKUK	212	DUKE OF YORK ISLANDS	438,938	9,544,211	OLD_GPS
USEWIT PLNTN	33	LASSUL BAINING	343,687	9,533,990	100K_TOPO
UTUAN 1	150	DUKE OF YORK ISLANDS	437,700	9,532,290	NMB_GPS
UTUAN 2	121	DUKE OF YORK ISLANDS	438,113	9,532,090	NSO1983
UVOL	201	MELKOI	277,371	9,335,466	OLD_GPS

UVOL CATH MISS	22	MELKOI	278,871	9,334,681	OLD_GPS
VALAUR	328	WATOM ISLAND	395,321	9,545,723	NMB_GPS
VARZIN PLNTN	84	VUNAMAMI	408,870	9,516,160	NMB_GPS
VATNABARA NURSING SCH	24	DUKE OF YORK ISLANDS	434,779	9,534,979	NSO1983
VIMY PLNTN	170	BITAPAKA	420,299	9,509,648	ESTIMATED
VIOSIPUNA	112	WEST POMIO	292,891	9,369,144	OLD_GPS
VIRIEN	127	DUKE OF YORK ISLANDS	439,850	9,532,700	NMB_GPS
VITAVUN PLNTN	28	SINIVIT/EAST_BAINING	402,390	9,499,217	OLD_GPS
VIVIRAN	528	TOMA	407,223	9,511,716	OLD_GPS
VOLAVOLO (BAL)	544	BALANATAMAN	404,991	9,538,081	OLD_GPS
VOLAVOLO (LIV)	194	LIVUAN	389,553	9,531,844	NSO1983
VUDAL AGRIC COLLEGE	394	LASSUL BAINING	390,052	9,518,869	OLD_GPS
VUDAL LSS	320	LASSUL BAINING	385,523	9,520,296	NSO1983
VUNABALBAL	394	VUNAMAMI	414,848	9,518,915	OLD_GPS
VUNABAUR	185	BITAPAKA	423,461	9,507,077	OLD_GPS
VUNABUK	428	WATOM ISLAND	396,179	9,543,823	OLD_GPS
VUNADAVAI	556	LIVUAN	390,748	9,536,603	OLD_GPS
VUNADIDIR	389	TOMA	405,029	9,518,588	OLD_GPS
VUNADIDIR CENTRE	59	TOMA	404,785	9,519,303	NMB_GPS
VUNAGOGO	316	CENTRAL	402,479	9,523,059	OLD_GPS
VUNAIRIMA PASTORS COLL	38	CENTRAL	392,410	9,528,256	ESTIMATED
VUNAIROTO	535	LIVUAN	399,306	9,535,789	OLD_GPS
VUNAITING	330	REIMBER	399,308	9,533,261	OLD_GPS
VUNAKABAI	365	WATOM ISLAND	398,272	9,543,882	OLD_GPS
VUNAKAINALAMA	328	REIMBER	399,830	9,531,628	OLD_GPS
VUNAKALUKALU	369	REIMBER	401,618	9,530,857	OLD_GPS
VUNAKAMBI PLNTN (CGZ)	77	CENTRAL	392,700	9,527,160	LANDS_DIV
VUNAKAMBI PLNTN (TOM)	220	TOMA	404,555	9,518,827	NSO1983
VUNAKANAU PLNTN	109	CENTRAL	397,416	9,522,134	NMB_GPS
VUNAKANAU ST PAULS	178	CENTRAL	403,460	9,522,714	NSO1983
VUNALAKA	292	REIMBER	402,842	9,528,842	OLD_GPS
VUNALAMA PLNTN	70	LASSUL BAINING	370,453	9,525,306	ESTIMATED
VUNALIR	243	LIVUAN	395,142	9,534,847	NSO1983
VUNAMAMI	674	VUNAMAMI	415,597	9,520,490	OLD_GPS
VUNAMAMI FARMERS TRA.SCH.	119	VUNAMAMI	410,520	9,515,190	NMB_GPS
VUNAMARITA COMM SCH	17	LASSUL BAINING	367,295	9,533,455	NSO1983
VUNAMURMUR	411	RALUANA	410,681	9,523,142	OLD_GPS
VUNAPAKA	425	REIMBER	398,106	9,530,549	OLD_GPS
VUNAPALADING LSS	140	LASSUL BAINING	379,569	9,517,686	NSO1983
VUNAPALADING STLMNT	295	LASSUL BAINING	379,310	9,518,894	NSO1983
VUNAPAU PLNTN	121	CENTRAL	397,246	9,521,337	NSO1983
VUNAPIT PLNTN	41	CENTRAL	398,310	9,521,400	NMB_GPS
VUNATAGIA	145	RALUANA	412,566	9,523,461	OLD_GPS
VUNAULAITING	425	REIMBER	398,993	9,529,085	OLD_GPS
VUNAULUL	384	RALUANA	409,666	9,522,184	OLD_GPS
VUNAVAI PLNTN	50	CENTRAL	396,720	9,522,020	NMB_GPS
VUVU PLNTN	64	BALANATAMAN	403,750	9,533,410	LANDS_DIV
WAIPO	66	MELKOI	246,434	9,340,269	OLD_GPS
WAIRA	216	DUKE OF YORK ISLANDS	443,538	9,540,419	OLD_GPS
WAIRIKI 1	491	TOMA	409,644	9,512,144	OLD_GPS
WAIRIKI 2	222	TOMA	409,371	9,511,390	OLD_GPS
WAIRIKI 3	322	TOMA	409,531	9,512,324	100K_TOPO
WAIRIKI PLNTN	49	VUNAMAMI	411,804	9,512,192	NMB_GPS
WAITA PLNTN	61	BITAPAKA	433,365	9,521,523	NMB_GPS
WANDUROO	26	VUNAMAMI	414,267	9,510,596	ESTIMATED
WARA SMIT PLNTN	56	SINIVIT/EAST_BAINING	411,313	9,508,241	NMB_APPRX
WARANGOI C.S.	19	SINIVIT/EAST_BAINING	407,150	9,505,800	NMB_GPS
WARANGOI DPI	9	SINIVIT/EAST_BAINING	407,623	9,506,319	NSO1983
WARANGOI PLNTN	747	SINIVIT/EAST_BAINING	407,700	9,504,650	ESTIMATED
WARANGOI POLICE STN	33	SINIVIT/EAST_BAINING	406,276	9,503,150	OLD_GPS
WARANGOI SAWMILL	93	SINIVIT/EAST_BAINING	411,448	9,507,049	OLD_GPS
WAREMULA PLNTN (WARENVULA)	23	BITAPAKA	422,300	9,504,960	LANDS_DIV
WARENA PLNTN	64	BITAPAKA	423,620	9,504,240	ESTIMATED
WARIK PLNTN	24	SINIVIT/EAST_BAINING	405,783	9,502,280	NMB_GPS
WASERA CAMP	117	RABAUL URBAN	409,100	9,532,700	ESTIMATED
WATARA	149	DUKE OF YORK ISLANDS	443,845	9,539,544	NMB_GPS
WATWAT (*)	20	BITAPAKA	425,144	9,506,597	OLD_GPS
WATWAT (*)	242	BITAPAKA	425,446	9,505,700	OLD_GPS
WAWAS	144	EAST POMIO	401,428	9,404,357	NMB_GPS
WEWAK STLMNT	159	RABAUL URBAN	409,100	9,532,600	ESTIMATED
WILIAMBEKI	493	LASSUL BAINING	347,994	9,499,961	OLD_GPS
WING MOW PLNTN	19	SINIVIT/EAST_BAINING	406,465	9,503,870	OLD_GPS
WONGAWONGA PLNTN NO.1	44	VUNAMAMI	413,200	9,512,120	NMB_GPS
WONGAWONGA PLNTN NO.2	65	VUNAMAMI	413,186	9,511,793	NSO1983
WOWONGA	58	MELKOI	258,150	9,333,730	NMB_GPS
YALOM	612	LASSUL BAINING	361,032	9,512,415	OLD_GPS
YAUYAU	76	WEST POMIO	274,010	9,377,601	OLD_GPS
YELALONA	140	WEST POMIO	288,896	9,370,858	NMB_GPS

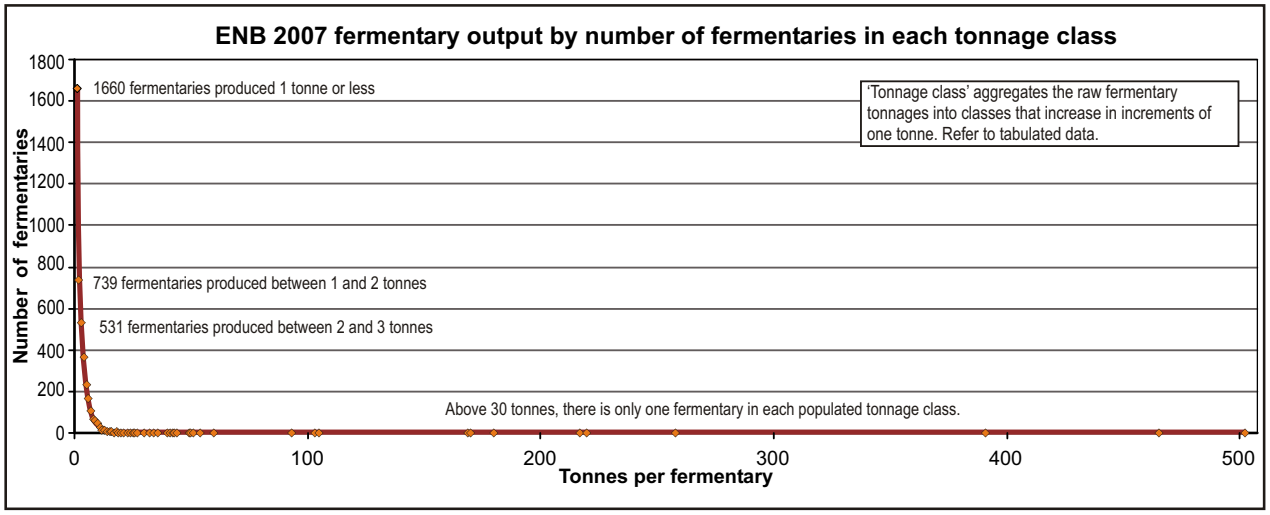


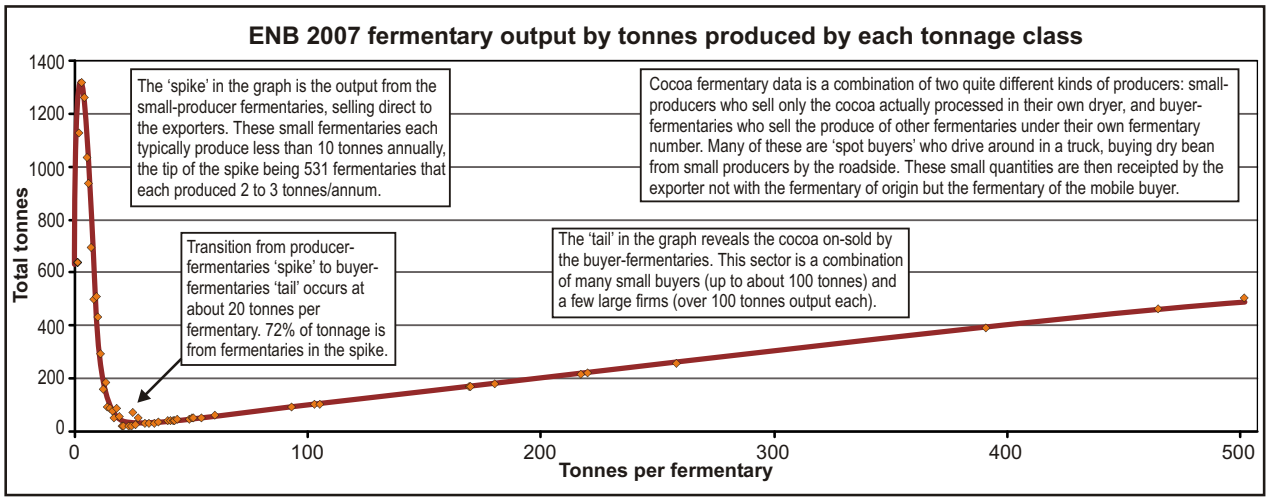
Appendix 5. Local Level Government area codes used in the data tables in the study. Note that this system is different from that used by the Papua New Guinea census coding. Numbers have been assigned in a spatial sequence and abbreviated names are used as codes.

Appendix 6. Cocoa fermentary data disaggregation.

Mapping of distribution of cocoa production was made from data collected routinely by Cocoa Board PNG. Cocoa Board has since 2005 entered data from every cocoa sales receipt into their 'bounty book' database. The database was queried to output the tonnage sold from each fermentary in East New Britain in the cocoa years 2006 and 2007 (within the Board's administrative system, both 'P' and 'N' series fermentaries were captured). The 2007 dataset was chosen for processing. In that year, there were 3083 'P' records, and 1015 'N' records. Each of these records also contained the fermentary number, its name, the owner's name, and owner's address. The intention was to relate this dataset to Cocoa Board records of fermentary location. This proved difficult, as a number of differing registration datasets existed within Cocoa Board for the ENB fermentaries, none of which were complete or up-to-date. Eventually odd lists were found for 'P' and 'N' series fermentaries that listed the ward location of most fermentaries. However the Board's practice is to re-issue a fermentary license number to a new fermentary when an old fermentary lapses, so the same number could refer to one or more fermentaries in different locations, depending on the age of the records. Some fermentaries will for this reason be mis-located in the new dataset constructed for the current study. This is thought to affect a minority of records and is a source of noise in the data. For geo-location, ward location is the closest approximation to actual location that is available for the data. The ward centroids were geo-located based on the work done in this study for census unit population mapping.

A more serious problem with the Cocoa Board records is that a number of fermentaries are in fact principally buyers, who on-sell the cocoa they have bought from others then sell it under their own fermentary number. This includes dry-bean produced in other fermentaries. The bounty books erroneously record production location (implicit in recorded the fermentary number) of thousands of tonnes of cocoa in this way. It was found through the data analysis of the accompanying graphs here, that much of this buyer-fermentary cocoa can be isolated from genuine producer-fermentary cocoa on the basis of tonnage produced. The graph shows genuine producers tend to produce small tonnages while buyer-fermentaries record large tonnages, and there is a sharp dip in the graph between the two types. This made it possible to filter off the tonnages recorded for buyer-fermentaries, and use just the subset of actual producer fermentaries, with their more-or-less accurate location, to complete the mapping.



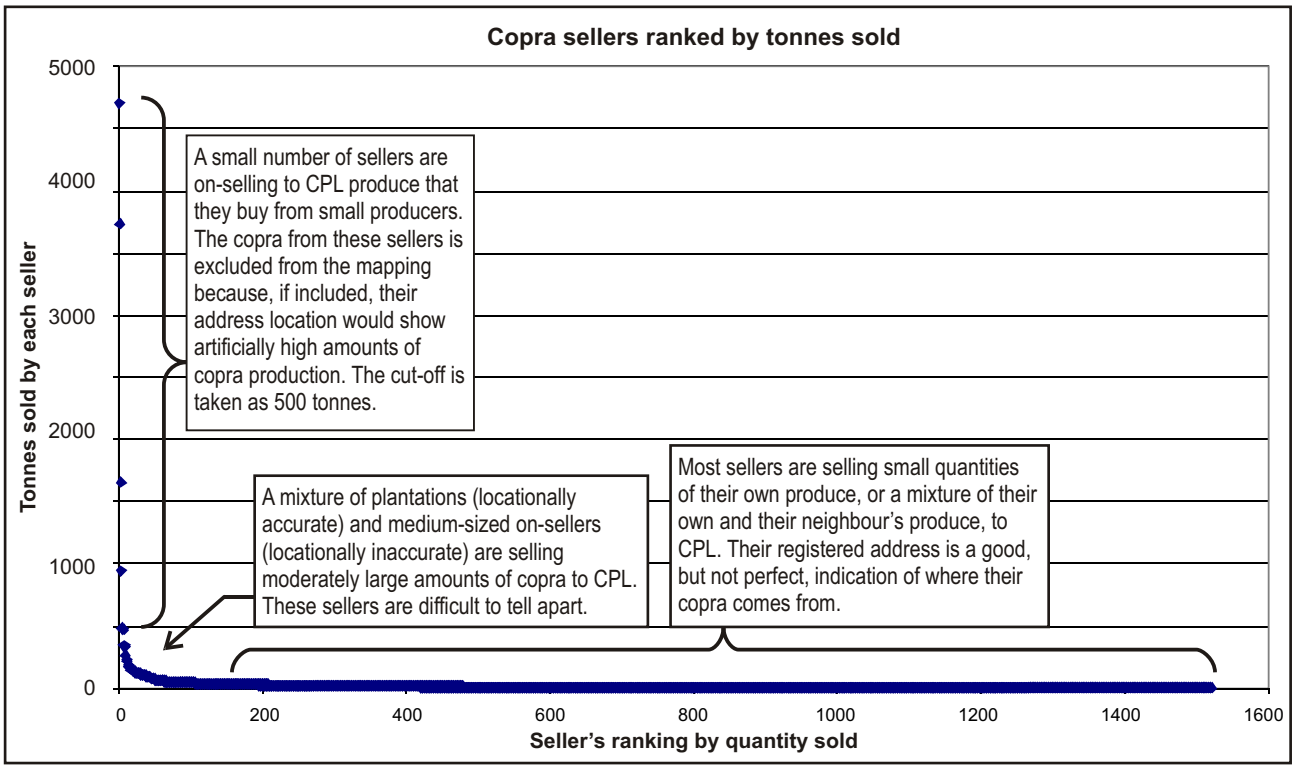


Appendix 7. Copra weighbridge data disaggregation.

Distribution of copra production in Gazelle Peninsula for 2008 was mapped using CPL Toboi Mill weighbridge records for copra sales. CPL is the largest copra export buyer in East New Britain. Weighbridge records from CPL Toboi Mill for the whole of 2008 were examined. These are computerised records generated when a truck delivers and sells copra to the Toboi mill. The weighbridge is used to weigh net tons delivered, a quality assessment is made, and payment is based on quality and mass. These computerised records are kept against the sellers name and a CPL seller's registration number. CPL provided the latest full year's records available. This was a spreadsheet of 45683 weighbridge records 01 Jan-31 Dec 2008. The raw data contained sale date, seller's CPL registration number, seller's name, seller's village location and LLG area, copra grade, and copra net weight in kilograms at sale.

Raw weighbridge data records were aggregated by seller's name, then seller's village locations were geolocated as far as possible. Not all seller's locations could be found. Effort was made to obtain a location for each seller. Where no location could be found, many of these failed matches were due to discrepancy in the seller's address that was too great to make sense of and repair. Some records, such as copra sold to CPL at the Toboi weighbridge from New Ireland, or by Agmark agents or even by other CPL depots, had no location data attached. The unlocated records were then discarded from analysis. In summary:

Total number of sellers in original data: 1966 sellers
Total number of sale records in original data: 45,683 records
Total copra tonnage recorded in original data: 35,241 tonnes
Total sellers for whom address was geolocated: 1520
Total records geolocated by seller's address: 39,362
Sellers addresses geolocated: 77%
Sale records geolocated: 86%
Total copra for which seller's address was geolocated: 29,899 tonnes (85% of total)
Copra for which seller's address could not be geolocated: 5,342 tonnes (15% of total)



While some smallholders deliver their own copra, and there are hundreds of such sellers, there are also many mobile copra spot buyers, who travel the roads by truck and buy copra at the farm gate, then on-sell the full truckload to CPL at Toboi. Some such sellers may deal anywhere from a few tonnes to hundreds of tonnes over the year. Some copra comes from a few remaining commercial plantations. Some copra was shipped from New Ireland to Toboi and delivered to the weighbridge by truck from another wharf.

Some caveat must be put on the geolocation. The locations on the original records was to locality, about ward level. 177 such locations were mapped. More important than this imprecision, large buyers are trucking copra from where it is produced and then when they sell, it is recorded as from their own home location. This may not be such a problem with smaller buyers who may be buying just within their own locality. Large buyers however might be buying much more widely. This distorts the mapped distribution.

To check on the possibility of distortion from large buyer activity, the geolocated weighbridge records were subtotalled by registered seller name. The 1520 resulting records, which is of each seller's 2008 annual tonnage sold to CPL, were then sorted by tonnage, with sellers of the highest tonnages at the top of the list and the smallest sellers at the bottom. For good measure the list was graphed, in this same ranked order, as a scattergram. The graph, which has the shape of an asymptotic decay curve, clearly showed four sellers were extremely large buyers, each selling between 900 and 5,000 tonnes. Together the 'Big 4' accounted for 9,385 tonnes, or 31% of all located tonnage. The 32 sellers of tonnages between 500 and 100 tonnes together accounted for further 5,932 tonnes, or 20% of located tonnage. These '100 to 500 tonne' sellers are a mix of large buyers and of plantations. A decision was made to remove the 'Big 4' sellers from the mapping, as they would certainly distort the distribution. The '100 to 500 tonne' sellers were reluctantly retained in the mapping because although the buyers among them are a distortion, the plantations among them are legitimate spatial data. And all smaller sellers were of course retained.

Finally, the mapping was produced in a 5km x 5km UTM grid, by instructing MapInfo to first filter out the 'Big 4' tonnages (greater than 500 tonnes), then 'update column' for the 5km grid table column 'Tonnes_2008' to calculate the sum within each grid cell of seller tonnes from the original seller list. That the mapping resolution is only to +/- 5km is appropriate, as the difficulties with the data as described above, preclude more detailed mapping.

Appendix 8. Local produce markets.

Mapping began with a spreadsheet of the questionnaire data from all markets. The home locations of the sellers were geolocated in this spreadsheet. Total records: 845, Total female: 813. Average females = 96%. Breakdown was:

```
Kokopo market   Thu 05-03-2009 (380 records, 360 female)
Rabaul market   Fri 03-04-2009 (324 records, 315 female)
Kerevat market  Wed 11-03-2009  (96 records,  93 female)
Warangoi market Fri 27-03-2009  (22 records,  22 female)
Nonga market    Fri 27-03-2009  (25 records,  23 female)
```

The data was then split into the four markets, with a spreadsheet for each. Each of these aggregated the data by seller's home location. These four sets of aggregated map data are:

```
Kokopo market   Thu 05-03-2009 (107 aggregate records)
Rabaul market   Fri 03-04-2009  (82 aggregate records)
Kerevat market  Wed 11-03-2009  (21 aggregate records)
Warangoi market Fri 27-03-2009  (10 aggregate records)
```

The fields in each are identical. They are: `VILLAGE` (the seller's home village); `NR SELLERS` (number of sellers who came to market from that place); `EARN_PER_PERSON` (the amount each person said they normally earned in a day at the market); `MALE`; `FEMALE` (gender of the seller); `LON` (UTM longitude); `LAT` (UTM longitude); `LLG_CODE`; `MARKET` (the market at which the survey was done). Reported earnings was unreliable at an individual level, but overall patterns did emerge. The surveyor was also asked to note the kind of produce sold (fruit/vegetables, prepared food, fresh fish, betel nut, tobacco, craft goods, other); this data was useful to cross check on reported earnings and distance travelled to market.

Two additional questions that in hindsight would have been helpful are: "how did you get to market today: a) PMV of any kind or b) other"; and "if you are selling for other people, do they live in the same ward as you or in a different ward?". The first question would indicate if public transport fares are as significant as has been assumed, and the second question would indicate if there are hidden market chains underlying the market, e.g. a Kokopo town woman selling produce that actually came from the Warangoi valley settlement areas. Kokopo market results are reproduced below.

VILLAGE_ORIGIN	LLG_CODE	NR_SELLERS	TOT_EST_EARN	AVG_EARN	MALES	FEMALES	LON	LAT
BAAI	KOM	6	450	75	0	6	413,760	9,534,886
BAINING LLG OFFICE	INB	1	100	100	0	1	385,680	9,515,860
BALADA	BIT	2	80	40	0	2	422,622	9,513,999
BALANATAMAN	RAL	2	110	55	0	2	413,510	9,521,310
BAROVON	RAL	2	60	30	0	2	412,388	9,524,909
BIRAR	BIT	1	40	40	0	1	427,424	9,512,926
BITABAUR	RAL	4	270	68	0	4	411,788	9,522,781
BITAPAKA	BIT	6	300	50	0	6	422,552	9,513,170
BITATITA	RAL	2	50	25	0	2	408,993	9,523,280
BITAVAVAR	KOV	4	265	66	0	4	414,270	9,518,100
BUTAM	SIN	1	50	50	0	1	414,500	9,505,100
BUTUWIN	KOV	5	340	68	2	3	415,800	9,521,900
CLIFTON	KOV	8	420	53	0	8	415,150	9,507,900
GAULIM	INB	4	430	108	0	4	399,500	9,509,400
GUNANBA	KOV	4	260	65	0	4	411,250	9,518,370
GUNANUR	TOM	10	860	86	0	10	405,870	9,520,900
IVERE VLG	INB	1	500	500	1	0	397,906	9,508,786
KABAGAP	BIT	1	70	70	0	1	432,576	9,518,725
KABAKAUL	KOV	4	270	68	0	4	425,430	9,520,150
KAINAGUNAN	INB	1	450	450	1	0	397,728	9,507,287
KARAVARA	DOY	1	200	200	0	1	435,671	9,531,166
KARAVI	KOV	4	290	73	0	4	414,650	9,521,422
KARAVIA	CGZ	8	650	81	0	8	406,350	9,525,800
KARAVIALIU	CGZ	1	125	125	0	1	405,400	9,524,400
KENABOT	KOV	6	310	52	1	5	418,550	9,519,100
KOKOPO	KOV	23	1245	54	1	22	419,000	9,519,700
KUNAKUNAI	RAL	2	90	45	0	2	409,000	9,520,650
KURADUI	RAL	3	180	60	0	3	413,400	9,522,950
LIAGA	INB	1	300	300	0	1	392,138	9,514,197
LIVUAN	RAL	1	60	60	0	1	409,130	9,522,160
MALAGUNA	BAL	2	140	70	0	2	406,450	9,535,300

MALAGUNA NO.1	BAL	2	290	145	0	2	406,500	9,535,150
MALAGUNA NO.2	BAL	4	630	158	0	4	406,250	9,534,130
MALAGUNA NO.3	BAL	1	75	75	0	1	405,560	9,532,960
MALAKUNA	BIT	1	100	100	0	1	429,020	9,515,899
MALAKUNA NO.4	KOV	1	80	80	0	1	411,987	9,513,870
MALAPAU	RAL	5	270	54	0	5	414,850	9,522,470
MALMALUAN	CGZ	7	645	92	0	7	404,957	9,525,042
MAMBUR	KOV	1	20	20	0	1	416,300	9,511,300
MANDRESS	INB	2	660	330	1	1	379,689	9,520,100
MAREN	DOY	1	600	600	1	0	440,537	9,543,255
MIOKO PALPAL	DOY	2	600	300	1	1	439,900	9,532,950
MOLOT	DOY	1	250	250	1	0	439,456	9,543,699
NABATA	LIR	1	100	100	0	1	397,682	9,534,460
NANGANANGA	RAL	5	300	60	0	5	409,300	9,522,150
NANUK	RAL	3	210	70	0	3	412,505	9,520,437
NAPAPAR	CGZ	3	1000	333	0	3	402,314	9,520,729
NAPAPAR NO.2	CGZ	1	100	100	0	1	402,066	9,520,253
NAPAPAR NO.3	CGZ	2	125	63	0	2	400,203	9,520,402
NAPAPAR NO.5	CGZ	1	600	600	0	1	397,489	9,518,793
NAVUNARAM	CGZ	20	1880	94	0	20	403,222	9,525,142
NGATUR	RAL	2	70	35	0	2	409,998	9,519,354
NGUVALIAN	RAL	2	110	55	0	2	409,534	9,523,410
PALNAKAUR	KOV	2	120	60	0	2	419,928	9,518,003
RABAGI	TOM	2	700	350	0	2	405,464	9,516,402
RABUANA	KOM	1	40	40	0	1	411,516	9,537,704
RABURUA	RAL	1	40	40	0	1	407,920	9,523,970
RAIM	TOM	7	625	89	0	7	405,900	9,520,500
RAINAU	BIT	4	220	55	1	3	426,361	9,515,103
RAKUNAI	CGZ	5	440	88	0	5	402,780	9,527,400
RALALAR	RAL	12	690	58	0	12	408,118	9,522,161
RALUANA	RAL	3	80	27	0	3	413,481	9,524,076
RALUBANG	BIT	1	30	30	0	1	423,323	9,510,457
RALUM	KOV	1	30	30	0	1	417,990	9,520,900
RAMALMAL	LIR	1	100	100	0	1	400,606	9,532,974
RANGUNA	RAL	1	80	80	0	1	412,023	9,521,291
RANIOLO	KOV	8	570	71	2	6	418,727	9,518,222
RAPITOK	TOM	2	410	205	0	2	402,349	9,517,591
RATAVUL	TOM	2	180	90	0	2	404,205	9,519,697
RAVAT	RAL	2	80	40	0	2	409,146	9,519,040
RIEIT	SIN	1	460	460	0	1	400,465	9,496,080
SIKUT	SIN	2	90	45	0	2	414,909	9,502,969
SONOMA	KOV	3	150	50	0	3	415,611	9,510,642
SULKA	BIT	1	30	30	0	1	425,800	9,502,600
TABANGAT	CGZ	1	100	100	0	1	401,000	9,520,100
TAKEKEL	CGZ	2	600	300	0	2	403,358	9,522,199
TAKUBAR	KOV	16	805	50	2	14	421,736	9,519,964
TALAKUA	RAL	14	1215	87	0	14	406,044	9,522,717
TALVAT	SIN	1	100	100	0	1	411,300	9,499,900
TAMANAIRIK	TOM	2	70	35	0	2	406,675	9,514,820
TANAKA	TOM	4	275	69	0	4	407,598	9,519,183
TAPO	BIT	4	290	73	2	2	424,850	9,514,600
TAVANA	BAL	3	325	108	0	3	405,958	9,528,674
TAVUILIU	CGZ	9	650	72	0	9	404,421	9,526,262
TINGANAGALIP	CGZ	8	995	124	0	8	402,738	9,523,845
TINGANALOM	RAL	4	140	35	0	4	410,695	9,520,666
TOGORO	BIT	1	75	75	0	1	423,633	9,512,652
TOKUA	BIT	3	220	73	1	2	428,691	9,520,267
TOMA	TOM	1	100	100	0	1	407,900	9,515,550
TURAGUNAN	RAL	3	120	40	0	3	408,506	9,521,149
ULAGUNAN	KOV	4	240	60	0	4	416,528	9,516,554
URUKUK	DOY	1	200	200	0	1	438,938	9,544,211
VALAUR	BAL	1	60	60	0	1	405,960	9,529,630
VARANA	BIT	2	140	70	0	2	423,000	9,503,250
VARZIN	KOV	2	550	275	0	2	408,900	9,516,150
VIMY PLNTN	BIT	1	105	105	0	1	420,299	9,509,648
VUNADIDIR	TOM	4	220	55	0	4	405,029	9,518,588
VUNAKABI	TOM	1	100	100	0	1	405,192	9,519,240
VUNALAKA	LIR	4	350	88	1	3	402,842	9,528,842
VUNAMAMI	KOV	11	600	55	0	11	415,597	9,520,490
VUNAMURMUR	RAL	1	70	70	0	1	410,681	9,523,142
VUNAPALADING	INB	1	70	70	0	1	387,400	9,517,040
VUNAPOPE	KOV	11	440	40	1	10	420,353	9,519,789
VUNATAGIA	RAL	2	115	58	0	2	412,566	9,523,461
VUNAULUL	RAL	1	30	30	0	1	409,666	9,522,184
WAIRIKI	TOM	1	200	200	0	1	409,644	9,512,144
WARANGOI	SIN	5	340	68	0	5	407,154	9,506,000

Appendix 9. School enrolments, Q2 2008

9(a). East New Britain Primary School enrolments, quarter 2, 2008. Source: ENBPA Division of Education. Schools recorded: 151. Schools geolocated: 149. Total students recorded: 35,364. Projection: WGS84 Zone 56S.

SCH_NAME	TYPE	LLG	AGENCY	TOT_STUD	TOT_STAFF	LON	LAT	LOC_SOURCE
ALAKASAM PS	PS	INB	CATH	133	5	370,891	9,504,173	NMB_GPS
AONA PS	PS	WPM	CATH	110	7	282,664	9,365,357	NMB_GPS
ARABAM PS	PS	SIN	CATH	98	4	401,734	9,491,856	NMB_GPS
BAGO PS	PS	CIP	GOVT	104	6	318,129	9,428,213	NMB_GPS
BALIORA PS	PS	KOV	GOVT	316	9	410,473	9,516,140	NMB/GE
BILI PS	PS	WPM	GOVT	122	4	288,784	9,373,506	NMB-GPS
BILLY MEMORIAL PS	PS	WAT	U/C	137	8	397,250	9,545,610	T.BOLA/GE
BILUR PS	PS	BIT	U/C	163	7	428,317	9,511,536	NMB-GPS
BIRAR PS	PS	BIT	CATH	178	6	427,424	9,512,924	NMB-GPS
BITAPAKA PS	PS	BIT	CATH	384	12	421,984	9,512,252	NMB-GPS
BITAPETEP PS	PS	RAL	U/C	248	6	413,475	9,521,350	ESTIMATED
BOVALPUN PS	PS	CIP	GOVT	186	3	345,322	9,385,532	NMB-GPS
BUTLIVUAN PS	PS	DOY	GOVT	248	12	441,666	9,541,766	NMB-GPS
CLIFTON PS	PS	BAL	GOVT	198	8	414,875	9,507,500	ESTIMATED
GALUWE PS	PS	CIP	GOVT	57	3	331,974	9,389,337	NMB-GPS
GAULIM PS	PS	INB	U/C	398	16	399,509	9,509,410	NMB-GPS
GUMA PS	PS	EPO	CATH	228	9	399,496	9,416,840	NMB-GPS
GUNANBA PS	PS	KOV	CATH	304	14	411,249	9,518,368	NMB-GPS
GUNANUR PS	PS	TOM	CATH	151	6	405,908	9,521,296	NMB-GPS
IATAPAL PS	PS	LIR	CATH	467	15	398,832	9,529,968	NMB-GPS
IRENA PS	PS	WPM	CATH	62	3	327,400	9,379,013	NMB-GPS
IWAI PS	PS	EPO	GOVT	89	4	397,080	9,419,717	NMB-GPS
KABAGAP PS	PS	RAL	GOVT	581	23	432,576	9,518,724	NMB-GPS
KABAIRA PS	PS	LIR	CATH	223	7	390,081	9,531,539	NMB-GPS
KABALEO PS	PS	KOV	CATH	467	18	421,468	9,517,792	NMB-GPS
KABATIRAI PS	PS	DOY	U/C	64	4	441,287	9,534,804	NMB-GPS
KABIAN PS	PS	DOY	GOVT	294	8	440,140	9,532,400	NSO1983
KABILOMO PS	PS	DOY	U/C	200	7	438,568	9,541,775	NMB-GPS
KADAULUNG PS	PS	INB	CATH	144	6	402,189	9,507,783	NMB-GPS
KAITON PS	PS	WPM	CATH	166	6	325,904	9,370,180	OLD-GPS
KALAMANAGUNAN PS	PS	KOV	GOVT	903	28	415,650	9,520,560	OLD-GPS/GE
KAMANAKAM PS	PS	INB	GOVT	195	7	369,931	9,528,046	NMB-GPS
KAORO PS	PS	MEL	CATH	93	4	296,133	9,341,950	NMB-GPS
KARAWARA PS	PS	DOY	GOVT	134	5	435,670	9,531,050	NMB/GE
KAUKUM PS	PS	EPO	GOVT	94	5	386,530	9,429,245	NMB-GPS
KAVUDEMKI PS	PS	SIN	GOVT	0	2	384,700	9,455,400	NMB-GPS/GE
KAWA PS	PS	CIP	GOVT	140	5	352,992	9,390,844	NMB-GPS
KENMININGA PS	PS	MEL	CATH	39	3	280,090	9,347,920	OLD-GPS
KEREVAT PS	PS	CGZ	GOVT	567	19	394,760	9,511,198	NMB-GPS
KOKOPO PS	PS	KOV	GOVT	844	18	418,190	9,519,900	ESTIMATED
KOLOPOM PS	PS	LAB	GOVT	181	4	354,763	9,532,612	NMB-GPS
KORPUN PS	PS	EPO	GOVT	54	5	393,265	9,397,048	NMB-GPS
KULUNIO MEMORIAL PS	PS	BIT	U/C	180	6	431,000	9,514,347	NMB-GPS/GE
LAU PS	PS	WPM	GOVT	89	6	314,678	9,355,656	NMB-GPS
LAUN PS	PS	LAB	CATH	119	5	361,330	9,530,700	OLD-GPS
LIAGA PS	PS	INB	U/C	33	4	392,138	9,514,196	NMB-GPS
LUNGALUNGA PS	PS	LIR	GOVT	139	7	387,190	9,534,317	NMB-GPS
MAKAEN PS	PS	WPM	CATH	255	10	329,961	9,377,585	NMB-GPS
MALAGUNA PS	PS	BAL	GOVT	558	19	406,512	9,535,149	NMB-GPS
MALAGUNAN PS	PS	BAL	CATH	449	13	405,550	9,532,990	GPSexact/GE
MALAKUNA PS	PS	BIT	GOVT	365	16	427,823	9,515,179	NMB-GPS
MALAKUR PS	PS	CIP	CATH	229	7	327,981	9,384,405	NMB-GPS
MALASAET PS	PS	INB	GOVT	173	7	376,871	9,506,460	NMB-GPS
MANDARAMBIT PS	PS	LAB	U/C	18	2	362,000	9,477,000	NMB-GPS
MANDRESS PS	PS	INB	GOVT	165	7	379,689	9,520,289	NMB-GPS
MAPUNA PS	PS	WPM	GOVT	0	4	287,617	9,363,543	NMB-GPS

MARUNGA PS	PS	SIN	CATH	92	6	393,950	9,450,500	NMB-GPS/GE
MASO PS	PS	MEL	CATH	230	8	284,690	9,337,360	NMB-APPRX
MASUARI PS	PS	CIP	CATH	76	3	329,327	9,427,341	NMB-GPS
MATANAKUNAI PS	PS	LAB	GOVT	77	4	354,247	9,462,171	NMB-GPS
MATONG PS	PS	CIP	CATH	173	6	362,283	9,385,309	NMB_GPS
MATUPIT ISLAND PS	PS	KOM	GOVT	0	3	409,700	9,531,180	GE-approx
MILE PS	PS	CIP	CATH	218	8	320,428	9,410,489	NMB-GPS
MILMILA PS	PS	DOY	CATH	182	7	441,027	9,535,932	NMB-GPS
MOPE PS	PS	BIT	CATH	152	8	426,800	9,506,800	1943MAP/GE
MUELA PS	PS	CIP	GOVT	94	3	324,861	9,420,120	NMB-GPS
MUNGOU PS	PS	SIN	CATH	115	7	430,157	9,481,445	NMB-GPS
NAGAILA PS	PS	DOY	U/C	1519	6	434,434	9,545,588	NMB-GPS
NAKUKUR PS	PS	DOY	U/C	172	7	434,931	9,539,824	NMB-GPS
NANGANANGA PS	PS	RAL	CATH	439	15	409,130	9,522,160	100KTOPO/GE
NAPAPAR MSSN PS	PS	CGZ	CATH	351	17	402,030	9,520,350	GPSexact/GE
NAPAPAR SDA PS	PS	CGZ	SDA	163	4	402,000	9,520,450	ESTIMATED
NAVEO PS	PS	WAT	CATH	119	5	398,830	9,545,600	NSO1983/GE
NAVUNARAM PS	PS	CGZ	GOVT	541	16	403,440	9,525,920	NMB/GE
NONGIA PS	PS	SIN	CATH	89	5	425,500	9,466,640	NMB/GE
NORDUP PS	PS	KOM	CATH	163	6	411,700	9,536,660	NMB/GE
NUTUVE A PS	PS	CIP	CATH	188	4	351,711	9,410,302	NMB-GPS
OPEN BAY PS	PS	LAB	GOVT	108	7	355,029	9,468,970	NMB-GPS
PAKA PS	PS	WPM	CATH	49	3	292,590	9,372,720	ESTIMATED
PAPALABA PS	PS	TOM	GOVT	104	4	404,820	9,511,528	NMB-GPS
PAPARATAVA PS	PS	TOM	CATH	462	18	408,350	9,514,440	ESTIMATED
PILAPILA PS	PS	BAL	GOVT	357	14	404,277	9,536,337	NMB-GPS
PILEMATANA PS	PS	MEL	CATH	99	4	275,760	9,339,570	NMB/GE
POKAPUNA	PS	WPM	U/C	124	7	292,530	9,372,815	NMB/GE
POMIO PS	PS	CIP	GOVT	209	9	336,200	9,389,380	OLD-GPS
PULPUL PS	PS	CIP	GOVT	125	4	378,000	9,387,630	OLD-GPS/GE
RABAGI PS	PS	TOM	GOVT	233	10	405,463	9,516,400	NMB-GPS
RABAUL ST. MARTINS PS	PS	RAB	CATH	93	4	408,450	9,536,000	ESTIMATED
RABURUA PS	PS	RAL	GOVT	357	13	407,877	9,524,078	NMB-GPS
RAKUNAI PS	PS	CGZ	CATH	561	20	402,779	9,527,398	NMB-GPS
RALUANA PS	PS	RAL	GOVT	604	21	413,481	9,524,075	NMB-GPS
RAMALMAL PS	PS	LIR	CATH	349	6	400,606	9,532,972	NMB-GPS
RANGULIT PS	PS	INB	GOVT	187	7	381,754	9,514,582	NMB-GPS
RAPUI PS	PS	LIR	CATH	121	13	403,100	9,531,670	T.BOLA/GE
RATONGOR PS	PS	LIR	CATH	323	11	394,103	9,535,721	NMB-GPS
RAUNSEPNA PS	PS	INB	CATH	256	10	365,131	9,507,338	NMB-GPS
RIET PS	PS	SIN	U/C	215	8	400,381	9,496,202	NMB-GPS
RUGEN HARBOUR PS	PS	SIN	SDA	83	5	428,440	9,494,800	NMB/GE
SAMPUN PS	PS	EPO	CATH	142	7	403,951	9,408,272	NMB-GPS
SANBAM PS	PS	SIN	U/C	98	5	415,835	9,491,508	NMB-GPS
SERENGUNA PS	PS	WPM	GOVT	125	7	302,858	9,365,023	NMB-GPS
SIKUT PS	PS	SIN	U/C	115	7	412,370	9,500,127	NMB-GPS
SIKUT-MATUPIT PS	PS	KOM	GOVT	240	8	413,175	9,504,610	GPSexact
SIKUT-TALWAT PS	PS	KOM	GOVT	139	8	411,279	9,499,902	NMB-GPS
SIVAUNA PS	PS	WPM	GOVT	133	7	289,216	9,351,794	NMB-GPS
SONOMA SDA PS	PS	KOV	SDA	231	10	415,660	9,510,600	NMB/GE
SPANGO PS	PS	EPO	GOVT	119	6	384,044	9,443,757	NMB-GPS
TABANGAT PS	PS	CGZ	U/C	202	7	401,008	9,520,341	NMB-GPS
TAKABUR PS	PS	KOV	CATH	415	14	413,185	9,516,200	NSO1983/GE
TAKIS (ST. JOSEPH) PS	PS	LAB	CATH	72	5	333,707	9,534,754	NMB-GPS
TAMANAIRIK PS	PS	TOM	CATH	144	7	404,345	9,513,942	NMB-GPS
TANAKA PS	PS	TOM	U/C	345	15	407,598	9,519,181	NMB-GPS
TANGOLO PS	PS	MEL	CATH	0	4	258,454	9,336,277	NMB-GPS
TAPO PS	PS	BIT	CATH	324	13	424,825	9,514,426	NMB-GPS
TAULIL PS	PS	TOM	CATH	165	6	399,271	9,512,124	NMB-GPS
TAURAN PS	PS	TOM	GOVT	375	17	405,850	9,509,740	NMB-GPS
TAVATAVUL PS	PS	TOM	CATH	207	7	456,000	9,510,000	no-loc
TAVILO PS	PS	CGZ	GOVT	229	8	392,544	9,524,276	NMB-GPS
TAVUI PS	PS	BAL	GOVT	464	19	406,384	9,541,789	NMB-GPS

TAVUILIU PS	PS	CGZ	CATH	364	12	404,421	9,526,260	NMB-GPS
TINGANAGALIP PS	PS	CGZ	CATH	166	4	410,695	9,520,664	NMB-GPS
TOBERA PS	PS	BIT	CATH	180	8	417,770	9,511,880	ESTIMATED
TOTOVEL PS	PS	LIR	U/C	257	10	398,987	9,530,272	NMB-GPS
TUDUNGAN PS	PS	TOM	GOVT	425	16	400,198	9,514,615	NMB-GPS
ULAGUNAN PS	PS	KOV	CATH	197	8	416,528	9,516,552	NMB-GPS
URAMAT RUNAM PS	PS	INB	U/C	36	3	456,000	9,506,000	no-loc
UVOL PS	PS	MEL	CATH	294	11	279,080	9,334,720	NMB/GE
VALMATKI PS	PS	LAB	U/C	102	4	339,565	9,516,764	NMB-GPS
VATARA PS	PS	DOY	U/C	149	6	443,845	9,539,543	NMB-GPS
VILIAM PEMKI PS	PS	LAB	CATH	110	6	347,994	9,499,960	NMB-GPS
VOLAVOLO PS	PS	BAL	CATH	366	12	404,990	9,538,079	NMB-GPS
VUDAL PS	PS	INB	GOVT	206	7	388,478	9,519,463	NMB-GPS
VUNADAVAI PS	PS	LIR	GOVT	223	7	390,748	9,536,602	NMB-GPS
VUNADIDIR PS	PS	TOM	CATH	387	15	404,905	9,518,440	NMB/GE
VUNAIRIMA PS	PS	LIR	U/C	286	12	392,400	9,528,260	NMB/1944-MAP
VUNAIROTO PS	PS	LIR	GOVT	369	13	399,305	9,535,787	NMB-GPS
VUNAKANAU PS	PS	CGZ	CATH	543	20	397,700	9,522,100	ESTIMATED
VUNALIR PS	PS	LIR	GOVT	264	12	394,710	9,535,178	NMB-GPS
VUNALOVO PS	PS	CGZ	CATH	258	14	398,180	9,519,400	GPSexact/GE
VUNAMARITA PS	PS	LAB	CATH	164	5	367,200	9,534,000	100KTOPO/GE
VUNAPALADING PS	PS	INB	GOVT	399	14	387,790	9,516,940	GPSexact/GE
VUNAVATIKAI PS	PS	LIR	U/C	117	7	400,430	9,529,150	NSO1983
VUNAVAVAR PS	PS	LIR	CATH	246	10	401,100	9,530,750	ESTIMATED
WAIRIKI PS	PS	TOM	CATH	441	14	409,640	9,512,000	ESTIMATED
WARANGOI PS	PS	SIN	GOVT	503	19	407,154	9,505,798	NMB-GPS
WARENA PS	PS	CGZ	U/C	203	8	423,100	9,502,760	ESTIMATED
GELAGELA (W'HOUSE) PS	PS	KOM	GOVT	639	22	416,110	9,512,340	NMB/GE-unconfirm
WATOM PS	PS	WAT	GOVT	159	6	395,270	9,546,445	NSO1983/GE
YALAM PS	PS	LAB	GOVT	129	5	361,031	9,512,414	NMB-GPS
YAUYAU PS	PS	WPM	U/C	117	5	274,009	9,377,599	NMB-GPS
YAWAKAKA ST.LEO'S PS	PS	BAL	CATH	73	3	404,010	9,534,510	100KTOPO/GE

9(b). ENB Secondary School enrolments, quarter 2, 2008. Source: ENBPA Div. Education. Total students recorded: 6287 .Projection: WGS84 Zone 56S.

SCH_NAME	TYPE	LLG	AGENCY	TOT_STUD	TOT_STAFF	LON	LAT	LOC_SOURCE
GEORGE BROWN SS	SS	LIR	U/C	510	27	392,354	9,527,670	NMB-GPS
KAMBUBU SS	SS	SIN	SDA	424	20	429,620	9,494,010	NMB/GE
KEREVAT NATIONAL SS	SS	CGZ	GOVT	-	-	394,140	9,518,670	NMB/GE
KOKOPO SS	SS	KOV	GOVT	1437	57	416,680	9,521,250	NMB/GE
MALABUNGA SS	SS	TOM	GOVT	815	35	400,000	9,513,780	NMB/GE
MALTEC SS	SS	RAB	GOVT	518	24	408,470	9,535,870	ESTIMATED
OLSH SS	SS	KOV	CATH	480	18	420,100	9,519,500	ESTIMATED
PALMALMAL SS	SS	WPO	GOVT	491	18	333,360	9,377,140	ESTIMATED
UTMEI SS	SS	INB	GOVT	656	27	381,490	9,516,930	NMB-GPS
VUVU (ST MARY'S) SS	SS	CGZ	CATH	530	28	403,420	9,522,545	NMB/GE
WARANGOI SS	SS	SIN	GOVT	426	17	405,720	9,503,040	GPSexact

9(c). ENB Vocational School enrolments, quarter 2, 2008. Source: ENBPA Div. Education. Total students recorded: .Projection: WGS84 Zone 56S.

SCH_NAME	TYPE	LLG	AGENCY	TOT_STUD	TOT_STAFF	LON	LAT	LOC_SOURCE
KABAIRA VS	VS	LIR	CATH	197	9	390,080	9,531,540	NMB-GPS
KABALEO VS	VS	KOV	CATH	360	11	421,470	9,517,790	NMB-GPS
KARLAI VS	VS	EPO	GOVT	132	6	383,040	9,438,330	NMB-GPS
MILMILA VS	VS	DOY	CATH	113	8	441,235	9,535,946	NMB-GPS
RAVAL VS	VS	LIR	GOVT	374	22	391,156	9,532,420	NMB-GPS
UVOL VS	VS	MEL	CATH	121	6	277,320	9,335,350	NMB-GPS
VUNAMAMI VS	VS	KOV	GOVT	572	22	410,600	9,515,300	NMB/GE
WOOLNOUGH VS	VS	RAL	U/C	782	25	413,130	9,524,350	NMB/GE

Appendix 10. Health facilities

10(a). ENB health centres. Source: ENBPA Div. Health establishment register, Nov. 2008. Projection: WGS84 zone 56 south.

NAME	TYPE	STATUS_NOV08	LLG_CODE	LON_UTM	LAT_UTM	LOC_SOURCE
AONA	Health sub-ctr	OPEN	WPM	282,665	9,365,360	NMB
BUTUWIN	Health Centre	OPEN	KOV	415,826	9,521,883	NMB
GAULIM	Health sub-ctr	OPEN	INB	399,509	9,509,413	NMB
GELAGELA	Health sub-ctr	OPEN	KOV	415,214	9,513,300	NMB
GUMA	Health sub-ctr	OPEN	EPO	399,250	9,416,750	NMB_APPRX
KERAVAT	Health Centre	OPEN	CGZ	393,639	9,519,205	NMB
LASSUL BAY	Health Centre	OPEN	LAB	357,500	9,533,300	NMB_APPRX
MARUNGA	Health sub-ctr	OPEN	SIN	393,958	9,450,533	NMB
MATONG	Health sub-ctr	OPEN	CIP	361,750	9,386,650	NMB_APPRX
MOLOT	Health Centre	OPEN	DOY	439,289	9,542,658	NMB
MUELA	Health sub-ctr	OPEN	CIP	324,862	9,420,123	NMB
MUNGOU	Health Centre	OPEN	SIN	430,157	9,481,448	NMB
NAPAPAR	Health sub-ctr	OPEN	CGZ	402,066	9,520,254	NMB
NONGA BASE HOSPITAL	Hospital	OPEN	BAL	405,681	9,540,219	NMB
NUTUVE	Health sub-ctr	OPEN	CIP	351,711	9,410,305	NMB
OPEN BAY	Health sub-ctr	OPEN	LAB	355,030	9,468,973	NMB
PALMALMAL	Health Centre	OPEN	WPM	332,900	9,377,400	NMB_APPRX
PAPARATAVA	Health sub-ctr	OPEN	TOV	407,694	9,515,548	NMB
POMIO	Health Centre	OPEN	CIP	335,150	9,389,759	NMB
RABAUL	Urban Clinic	OPEN	RAB	408,967	9,535,834	NMB
RAUNSEPNA	Health sub-ctr	OPEN	INB	365,131	9,507,340	NMB
SIVAUNA	Health Centre	OPEN	WPM	289,217	9,351,797	NMB
TAPIPIPI	Health Centre	OPEN	TOV	407,598	9,519,184	NMB
TAPO	Health sub-ctr	OPEN	BIT	424,825	9,514,429	NMB
UVOL	Health sub-ctr	OPEN	MEL	278,871	9,334,682	NMB
VATNABARA	Health sub-ctr	OPEN	DOY	434,723	9,535,084	NMB
VIOSOPUNA	Health Centre	OPEN	WPM	292,891	9,369,145	NMB
VUNAPAKA	Health Centre	OPEN	LIR	398,106	9,530,550	NMB
VUNAPOPE HOSPITAL	Hospital	OPEN	KOV	420,353	9,519,790	NMB
WARANGOI	Health Centre	OPEN	SIN	406,276	9,503,151	NMB

10(b). ENB aidposts. Source: ENBPA Div. Health establishment register, Nov. 2008. Projection: WGS84 zone 56 south.

NAME	TYPE	PARENT_HC	STATUS_NOV08	LLG_CODE	LON_UTM	LAT_UTM	LOC_SOURCE
ALAKASAM	Aidpost	KEREVAT	OPEN	INB	370,891	9,504,176	NMB
ARABAM	Aidpost	WARANGOI	OPEN	SIN	401,734	9,491,859	NMB
BAGO	Aidpost	MUELA	OPEN	CIP	318,130	9,428,216	NMB
BILI	Aidpost	VISOPUNA	OPEN	WPM	288,785	9,373,509	NMB
BOVALPUN	Aidpost	POMIO	OPEN	CIP	345,350	9,385,650	NMB_APPRX
CLIFTON	Aidpost	GELAGELA	OPEN	KOV	415,150	9,507,900	APPROX
GALUE	Aidpost	POMIO	OPEN	CIP	331,650	9,389,550	NMB_APPRX
GEORGE BROWN HS	Aidpost	KEREVAT	OPEN	LIR	392,350	9,527,660	APPROX
HOIYA	Aidpost	HOIYA	OPEN	EPO	383,150	9,432,000	NMB_APPRX
KABABIAI	Aidpost	MOLOT	OPEN	DOY	441,262	9,539,161	NMB
KABATIRAI	Aidpost	VATNABARA	OPEN	DOY	441,290	9,534,810	NMB
KADAULUNG	Aidpost	GAULIM	OPEN	SIN	404,182	9,504,693	NMB
KAITON	Aidpost	PALMALMAL	OPEN	WPM	325,904	9,370,181	NMB
KAMANAKAM	Aidpost	KEREVAT	OPEN	INB	371,179	9,526,290	NMB
KAMBUBU	Aidpost	MUNGOU	OPEN	SIN	429,515	9,493,890	NMB
KAORO	Aidpost	UVOL	OPEN	MEL	296,200	9,342,050	NMB_APPRX
KAPKENA	Aidpost	NUTUVE	OPEN	CIP	335,631	9,414,973	NMB
KARAWARA	Aidpost	VATNABARA	OPEN	DOY	435,600	9,531,050	NMB_APPRX
KARONG	Aidpost	MARUNGA	OPEN	SIN	414,256	9,451,645	NMB
KAWA	Aidpost	MATONG	OPEN	CIP	352,993	9,390,847	NMB
KENMININGA	Aidpost	UVOL	OPEN	MEL	280,090	9,347,920	APPROX
KOMGI	Aidpost	RAUNSEPNA	OPEN	LAB	359,737	9,516,391	NMB

KORPUN	Aidpost	GUMA	OPEN	EPO	393,265	9,397,051	NMB
LAKIRI	Aidpost	NUTUVE	OPEN	CIP	356,157	9,412,560	NMB
LAU	Aidpost	PALMALMAL	OPEN	WPM	314,700	9,355,700	NMB_APPRX
LOPUN	Aidpost	UVOL	OPEN	MEL	245,874	9,342,274	NMB
MAKAEN	Aidpost	PALMALMAL	OPEN	WPM	329,961	9,377,586	NMB
MALO	Aidpost	PALMALMAL	OPEN	WPM	322,500	9,374,000	NMB_APPRX
MALABUNGA	Aidpost	TAPIPIPI	OPEN	INB	398,200	9,509,800	APPROX
MALAKUR	Aidpost	POMIO	OPEN	CIP	327,538	9,384,479	NMB_APPRX
MALASAET	Aidpost	KEREVAT	OPEN	INB	376,871	9,506,463	NMB
MANDRESS NO.1	Aidpost	KEREVAT	OPEN	INB	379,689	9,520,292	NMB
MAPUNA	Aidpost	AONA	OPEN	WPM	287,617	9,363,546	NMB
MASO	Aidpost	UVOL	OPEN	MEL	284,650	9,337,400	NMB_APPRX
MASUARI	Aidpost	MUELA	OPEN	CIP	329,327	9,427,344	NMB
MATANAKUNAI	Aidpost	OPEN BAY	OPEN	LAB	354,247	9,462,174	NMB
MILE	Aidpost	MUELA	OPEN	CIP	320,429	9,410,492	NMB
MILIM	Aidpost	HOIYA	OPEN	EPO	388,100	9,425,900	NMB_APPRX
MIOKO/PALPAL	Aidpost	VATNABARA	OPEN	DOY	439,950	9,532,800	NMB_APPRX
MOPE	Aidpost	TAPO	OPEN	BIT	426,800	9,506,800	APPROX
MU	Aidpost	HOIYA	OPEN	EPO	392,650	9,423,700	NMB_APPRX
NONGIA	Aidpost	MUNGOU	OPEN	SIN	423,769	9,463,749	NMB
OLAIPUN	Aidpost	POMIO	OPEN	CIP	337,902	9,391,708	NMB
PAKIA	Aidpost	MUELA	OPEN	CIP	322,299	9,408,407	NMB
PILEMATANA	Aidpost	UVOL	OPEN	MEL	275,513	9,339,267	NMB
PONIARA	Aidpost	LASSUL BAY	OPEN	LAB	347,400	9,499,700	NMB_APPRX
PUKTAS	Aidpost	LASSUL BAY	OPEN	LAB	364,214	9,530,624	NMB
PULIPUNA	Aidpost	AONA	OPEN	WPM	277,506	9,364,825	NMB
PULPUL	Aidpost	MATONG	OPEN	CIP	377,774	9,387,394	NMB
RABAGI	Aidpost	TAPIPIPI	OPEN	TOV	402,938	9,515,054	NMB
RAKIVAL	Aidpost	RABAUL	OPEN	WAT	397,479	9,547,251	NMB
RAKUNAI	Aidpost	VUNAPAKA	OPEN	CGZ	402,780	9,527,400	NMB
RAMALMAL	Aidpost	VUNAPAKA	OPEN	LIR	400,606	9,532,975	NMB
RAPITOK	Aidpost	TAPIPIPI	OPEN	TOV	402,349	9,517,592	NMB
RAU	Aidpost	RABAUL	OPEN	WAT	396,733	9,545,332	NMB
REIGAL	Aidpost	WARANGOI	OPEN	SIN	406,680	9,483,150	APPROX
SAMPUN	Aidpost	GUMA	OPEN	EPO	403,600	9,408,250	NMB_APPRX
SANBAM	Aidpost	MUNGOU	OPEN	SIN	415,000	9,492,200	APPROX
SENMAGI	Aidpost	GAULIM	OPEN	INB	396,500	9,504,900	APPROX
SERENGUNA	Aidpost	VISOPUNA	OPEN	WPM	302,859	9,365,026	NMB
SIKUT 1	Aidpost	GELAGELA	OPEN	SIN	412,371	9,500,130	NMB
SIKUT 2	Aidpost	GELAGELA	OPEN	SIN	412,324	9,500,138	NMB
SPANGO	Aidpost	HOIYA	OPEN	EPO	384,045	9,443,760	NMB
TAKABUR	Aidpost	BUTUWIN	OPEN	KOV	412,831	9,516,001	NMB
TAKIS	Aidpost	LASSUL BAY	OPEN	LAB	333,750	9,534,550	NMB_APPRX
TANGOLO	Aidpost	UVOL	OPEN	MEL	258,449	9,336,277	NMB
TOKAI	Aidpost	MATONG	OPEN	CIP	358,300	9,390,631	NMB
TOKIALA	Aidpost	KEREVAT	OPEN	CGZ	393,401	9,523,663	NMB
TUKE	Aidpost	MUELA	OPEN	CIP	331,403	9,420,898	NMB
VALAUR (BAL)	Aidpost	RABAUL	OPEN	BAL	405,960	9,529,630	APPROX
VALILIE/UTMEI	Aidpost	KEREVAT	OPEN	INB	381,000	9,517,000	APPROX
VIVIRAN	Aidpost	PAPARATAVA	OPEN	TOV	405,851	9,509,743	NMB
VUDAL	Aidpost	KEREVAT	OPEN	INB	390,000	9,518,800	APPROX
VUNAIRIMA	Aidpost	KEREVAT	OPEN	LIR	392,692	9,528,607	NMB
VUNAIROTO	Aidpost	VUNAPAKA	OPEN	LIR	399,306	9,535,790	NMB
VUNAKAUR	Aidpost	PAPARATAVA	OPEN	TOV	405,676	9,512,999	NMB
VUNAMARITA	Aidpost	LASSUL BAY	OPEN	LAB	367,000	9,534,000	NMB_APPRX
VUNAPALADING	Aidpost	KEREVAT	OPEN	INB	385,678	9,515,858	NMB
VUNGA	Aidpost	GAULIM	OPEN	INB	396,005	9,501,527	NMB
WAIRIKI	Aidpost	PAPARATAVA	OPEN	TOV	409,371	9,511,391	NMB
WALMETKI	Aidpost	LASSUL BAY	OPEN	LAB	339,566	9,516,766	NMB
WARENA S'MNT	Aidpost	GELAGELA	OPEN	BIT	422,951	9,503,191	NMB
WATARA	Aidpost	MOLOT	OPEN	DOY	443,850	9,539,550	APPROX
YALAM	Aidpost	RAUNSEPNA	OPEN	LAB	361,032	9,512,416	NMB
YAUYAU	Aidpost	AONA	OPEN	WPM	274,010	9,377,602	NMB

Appendix 11. Gazelle Restoration expenditure 1995-2008

11a. Summary of ITRP actual expenditure by agency by sector, as at 31-12-00
Amounts in Kina, table built from full recalculation of GRA line items.

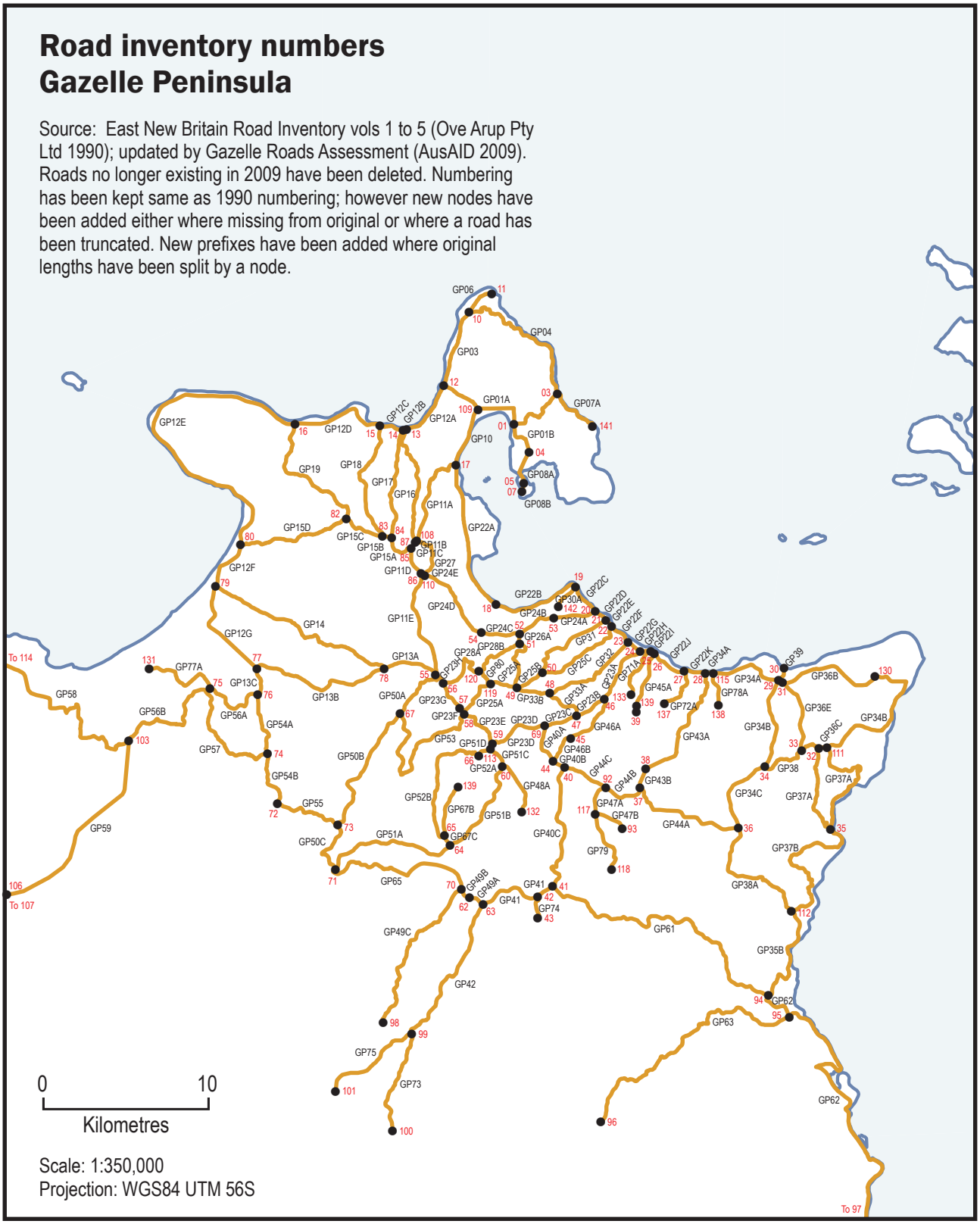
Sector	World Bank	AusAID	EU	GoPNG	JICA	ADB	Other	Total
Land Infrastructure	8,003,445	-	-	405,519	-	-	623,054	9,032,018
Air Transport	3,851,160	-	-	1,097,667	64,642,762	-	-	69,591,589
Sea transport	-	-	-	-	-	-	-	-
Roads - permanent	9,681,884	20,296,308	-	10,253	-	-	-	29,988,446
Roads - emergency	10,884,031	-	-	27,151	-	-	-	10,911,182
Electricity	-	-	-	67,340	-	-	-	67,340
Water	325,091	-	-	9,053	-	-	-	334,144
Sewerage & solid waste	-	-	-	-	-	-	-	-
Communications (radio)	-	-	-	30,467	19,935,777	-	-	19,966,245
Education	7,806,085	21,788,062	6,618,689	170,532	-	-	-	36,383,368
Health	2,631,603	-	-	406,539	-	1,315,909	1,513,947	5,867,998
Police	537,411	17,915,248	-	120,994	-	-	-	18,573,653
Volcano monitoring	34,177	162,683	-	41,692	-	-	-	238,553
Fire services	2,374,728	-	-	108,376	-	-	-	2,483,103
Community Development	-	394,528	-		-	416,857	-	811,384
Primary industry	93,046	-	859,361		-	673,202	18,801	1,644,410
Secondary industry	-	-	-		-	-	-	-
Administration	-	6,695,929	-	481,713	-	-	-	7,177,643
Preparation studies	-	-	-	-	-	-	-	-
Total	**46,222,661**	**67,252,759**	**7,478,049**	**2,977,296**	**84,578,539**	**2,405,968**	**2,155,802**	**213,071,074**

Source: Gazelle Restoration Authority spreadsheet "ITRP-imp-sched.xls", 2008. Note: some values are different from GRA recorded summary values. Discrepancies in AusAID amounts are due to GRA addition which forgot that some line items are in AUD. Cause of discrepancy in World Bank total is unknown.

11b. MTRP Phase 1 expenditure by sector by donor, for selected sectors, as at 21 Aug 2008. Values in Kina, table built from recalculation of GRA line items.

Sector	World Bank	AusAID	EU	GoPNG	JICA	ADB	OTHER	TOTAL
Land Infrastructure	167,269	-	1,011,852	-	-	-	414,000	1,593,121
Air Transport	-	-	-	-	-	-	-	-
Sea Transport	16,275,344	-	-	-	-	-	-	16,275,344
Roads	26,222,986	36,948,150	1,576,490	29,988,013	-	-	200,000	94,935,639
Electricity	1,014,816	164,676	4,930,077	142,000	-	-	-	6,251,568
Water	3,346,202	61,868	7,911,890	172,454	-	-	-	11,492,414
Sewerage & Solid waste	1,095,831	-	232,270	-	-	-	-	1,328,101
Communications (radio)	768,841	-	-	-	-	-	-	768,841
Education	17,833,767		1,875,998			-		19,709,765
Health	9,518,023		2,364,170	47,571	-	-	-	11,929,763
Law & Order (Police)	-	-	557,034	403,165	-	-	13,568	973,766
Volcano monitoring	-	-	-	-	-	-	-	-
Fire services	-	-	-	-	-	-	-	-
Community development	8,315,061	-	1,939,358	-	-	-	-	10,254,419
Primary industry	10,388,367	-	7,395,853	1,999,420	-	-	-	19,783,640
Secondary industry	1,386,338	-	-	564,567	-	-	-	1,950,905
Administration	1,382,748	-	-	-	-	-	-	1,382,748
Preparation studies	1,103,014	-	-	103,971	-	-	-	1,206,985
TOTAL	**98,818,605**	**37,174,695**	**29,794,991**	**33,421,160**	**-**	**-**	**627,568**	**199,837,018**

Source: Gazelle Restoration Authority spreadsheet "MTRP-imp-sched.xls", 2008.



Appendix 12a. Road inventory numbers map. Road and junction node numbers used in the roads inventory dataset. Numbers have been preserved from the 1990 East New Britain road inventory as far as possible. Some minor roads now present in the network but not present in 1990 are not included.

Appendix 12. Road inventory and condition assessment data

Original pavement condition assessment criteria, ENBP Roads Inventory 1990:

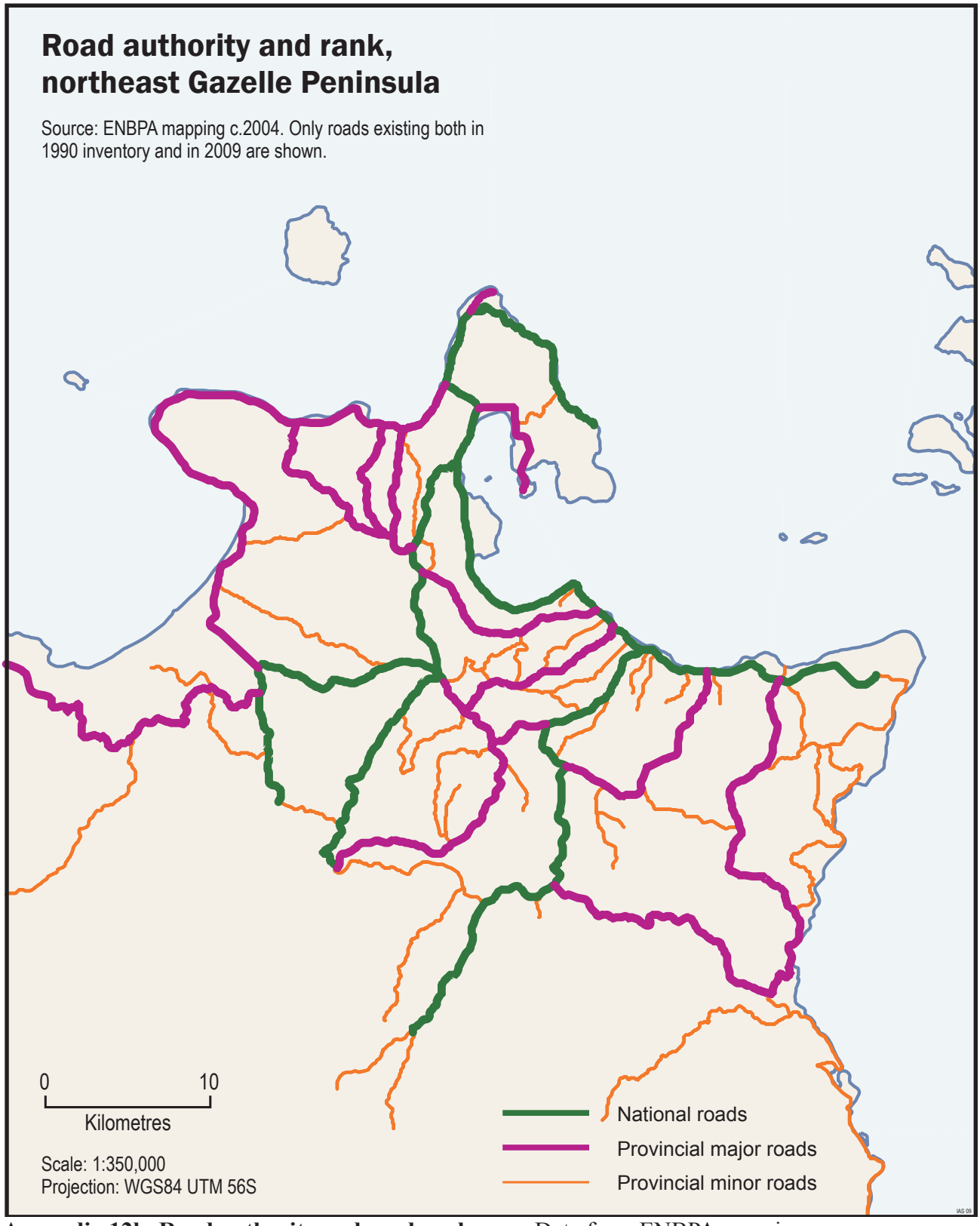
A. Sealed roads pavement condition:

1. Few potholes and no evident cracks
2. Occasional potholes and/or some cracks or rutting
3. Moderate potholes and/or obvious cracking or rutting
4. Frequent potholes and/or severe cracking or rutting

B. Unsealed roads pavement condition:

1. Smooth surface giving comfortable ride
2. Moderately corrugated surface giving minor discomfort
3. Severe corrugations giving uncomfortable ride and controlling speed.
4. Severe corrugations, soft spots, washouts etc., which needs to be negotiated carefully.

ROAD_NR	ROAD_NAME	LENGTH_KM	STARTNODE	ENDNODE	AGENCY_90	AGENCY_09	CONDTN_90	CONDTN_09	COND_CHANGE
GP01A	RABAUL TOWN RD	3.12	1	109	PG	PG	1	3	-2
GP01B	RABAUL TOWN RD	2.26	1	4	PG	PG	1	3	-2
GP02	TUNNEL HILL RD	2.59	109	12	PG	NG	1	2	-1
GP03	NONGA HOSPITAL RD	4.83	12	90	NG	NG	1	2	-1
GP04	ESCAPE RD	9.48	10	3	NG	NG	1	2	-1
GP05	NAMANULA RD	3.94	3	1	PG	PG	1	3	-2
GP06	TAVUI RD	1.91	10	11	PG	PG	2	2	0
GP07A	MATALAU-BAAI RD	3.26	3	141	NG	PG	1	4	-3
GP08A	RABAUL AIRPORT-MATUPIT	2.17	4	5	PG	PG	1	2	-1
GP08B	MATUPIT RD	0.60	5	7	PG	PG	1	4	-3
GP10	MALAGUNA RD	3.67	109	17	NG	NG	1	2	-1
GP11A	BURMA RD	6.22	17	108	NG	NG	1	2	-1
GP11B	BURMA RD	0.12	108	87	NG	NG	1	2	-1
GP11C	BURMA RD	0.44	87	85	NG	NG	1	2	-1
GP11D	BURMA RD	1.75	85	86	NG	NG	1	1	0
GP11E	BURMA RD	6.84	86	55	NG	NG	1	1	0
GP12A	NORTH COAST RD	3.68	12	13	PG	PG	1	4	-3
GP12B	NORTH COAST RD	0.23	13	14	PG	PG	1	3	-2
GP12C	NORTH COAST RD	1.49	14	15	PG	PG	1	3	-2
GP12D	NORTH COAST RD	5.90	15	16	PG	PG	1	4	-3
GP12E	NORTH COAST RD	20.74	16	80	PG	PG	1	2	-1
GP12F	NORTH COAST RD	3.21	80	79	PG	PG	2	2	0
GP12G	NORTH COAST RD	6.58	79	77	PG	PG	1	4	-3
GP13A	KEREVAT RD	3.39	55	78	PG	NG	1	1	0
GP13B	KEREVAT RD	8.89	78	77	PG	NG	1	1	0
GP13C	KEREVAT RD	1.73	77	76	PG	NG	1	1	0
GP14	TAVILO-NAPAPAR RD	12.27	79	78	PG	PG	3	3	0
GP15A	RAKUNAI-VUNAIRIMA RD	2.00	85	84	PG	PG	1	3	-2
GP15B	RAKUNAI-VUNAIRIMA RD	0.59	84	83	PG	PG	1	3	-2
GP15C	RAKUNAI-VUNAIRIMA RD	2.61	83	82	PG	PG	1	4	-3
GP15D	RAKUNAI - VUNAIRIMA RD	7.12	82	80	PG	PG	3	3	0
GP16	VUNALAKA-KURAIP RD	7.65	87	13	PG	PG	2	3	-1
GP17	KAVAVAR RD	6.98	84	14	PG	PG	1	4	-3
GP18	RAMALMAL RD	7.78	83	15	PG	PG	1	3	-2
GP19	VUNALIR RD	8.69	82	16	PG	PG	2	3	-1
GP22A	KOKOPO RD	9.29	17	18	NG	NG	1	1	0
GP22B	KOKOPO RD	5.42	18	19	NG	NG	1	1	0
GP22C	KOKOPO RD	1.99	19	20	NG	NG	1	1	0
GP22D	KOKOPO RD	0.83	20	21	NG	NG	1	1	0
GP22E	KOKOPO RD	0.55	21	22	NG	NG	1	1	0
GP22F	KOKOPO RD	1.46	22	23	NG	NG	1	1	0
GP22G	KOKOPO RD	0.91	23	24	NG	NG	1	1	0
GP22H	KOKOPO RD	0.65	24	25	NG	NG	1	1	0
GP22I	KOKOPO RD	0.23	25	26	NG	NG	1	1	0
GP22J	KOKOPO RD	2.29	26	27	NG	NG	1	1	0
GP22K	KOKOPO RD	1.32	27	28	NG	NG	1	1	0
GP23A	TOMA RD	3.94	24	46	NG	NG	1	1	0
GP23B	TOMA RD	2.02	46	47	NG	NG	1	1	0
GP23C	TOMA RD	2.04	47	69	NG	NG	1	1	0
GP23D	TOMA RD	3.79	69	59	NG	PG	1	2	-1
GP23E	TOMA RD	2.94	59	58	NG	PG	1	3	-2
GP23F	TOMA RD	0.48	57	58	NG	PG	1	2	-1
GP23G	TOMA RD	1.89	57	56	PG	PG	1	3	-2
GP23H	TOMA RD	0.71	56	55	PG	PG	1	2	-1
GP24A	KURADUI-NAVUNARAM RD	2.59	20	53	PG	PG	1	2	-1
GP24B	KURADUI-NAVUNARAM RD	2.42	53	52	PG	PG	1	4	-3
GP24C	KURADUI-NAVUNARAM RD	2.39	52	54	NG	PG	1	2	-1



Appendix 12b. Road authority and road rank map. Data from ENBPA mapping.

GP24D	KURADUI-NAVUNARAM RD	5.25	54	110	NG	PG	1	2	-1
GP24E	KURADUI-NAVUNARAM RD	0.27	110	86	PG	PG	1	2	-1
GP25A	MALAPAU-TOMATAVUR RD	1.65	119	49	PG	PG	1	2	-1
GP25A	MALAPAU-TOMATAVUR RD	2.93	57	119	PG	PG	1	1	0
GP25B	MALAPAU-TOMATAVUR RD	1.85	49	50	PG	PG	1	2	-1
GP25C	MALAPAU-TOMATAVUR RD	5.66	50	22	PG	PG	1	2	-1
GP26A	NGATUR RD	0.64	52	51	PG	PG	2	3	-1
GP26B	NGATUR RD	3.61	51	49	PG	PG	2	4	-2

GP27	LATLAT LOOP RD	3.02	110	108	PG	PG	9	4	5
GP28A	VUNADIDIR-TURAGUNAN RD	2.31	56	120	PG	PG	2	4	-2
GP28B	VUNADIDIR-TURAGUNAN RD	3.42	51	120	PG	PG	2	3	-1
GP30A	BAROVON RD	1.66	19	142	LG	PG	4	4	0
GP31	RANGUNA-RATAVUL RD	5.73	21	50	PG	PG	4	2	2
GP32	BUTUWIN-GUNANBA RD	6.13	23	48	PG	PG	3	3	0
GP33A	GIREGIRE-GUNANBA RD	2.56	47	48	PG	PG	4	3	1
GP33B	GIREGIRE-GUNANBA RD	2.16	48	49	PG	PG	3	3	0
GP34A	VUNAPOPE-BITAPAKA RD	4.52	115	29	NG	PG	1	2	-1
GP34A	VUNAPOPE-BITAPAKA RD	0.46	28	115	NG	PG	1	2	-1
GP34B	TOKUA LOOP RD	9.46	130	111	PG	PG	1	1	0
GP34B	VUNAPOPE-BITAPAKA RD	5.67	29	34	PG	PG	1	3	-2
GP34C	VUNAPOPE-BITAPAKA RD	5.06	34	36	PG	PG	1	3	-2
GP35B	BITAPAKA-GANAI RD	6.97	112	94	PG	PG	2	2	0
GP36A	TOKUA LOOP RD	0.27	29	31	NG	PG	2	1	1
GP36B	TOKUA LOOP RD	6.55	31	130	NG	PG	2	1	1
GP36C	TOKUA LOOP RD	0.50	111	32	PG	PG	1	2	-1
GP36D	TOKUA LOOP RD	1.24	32	33	PG	PG	2	2	0
GP36E	TOKUA LOOP RD	4.73	33	31	PG	PG	1	2	-1
GP37A	KABANGA LOOP RD	6.07	35	32	PG	PG	2	3	-1
GP37A	KABANGA LOOP RD	8.21	111	35	PG	PG	2	4	-2
GP37B	KABANGA-LONDIP RD	10.22	35	112	PG	PG	2	4	-2
GP38	TAUI RD	3.05	33	34	PG	PG	2	3	-1
GP38A	BITAPAKA-GANAI RD	8.10	36	112	PG	PG	2	3	-1
GP39	KABAKAUL WHARF RD	0.89	29	30	PG	PG	1	2	-1
GP40A	WARANGOI RD	2.49	69	44	NG	NG	1	1	0
GP40B	WARANGOI RD	0.84	44	40	NG	NG	1	1	0
GP40C	WARANGOI RD	8.50	40	41	NG	NG	1	1	0
GP41	WARANGOI RD HYDRO	5.12	41	63	NG	NG	2	1	1
GP42	WARANGOI RD INTAKE	9.83	63	99	NG	NG	2	3	-1
GP43A	VUNAPOPE-TOBERA RD	7.96	28	38	PG	PG	9	3	6
GP43B	VUNAPOPE-TOBERA RD	1.22	38	37	PG	PG	9	2	7
GP44A	RALUBANG-TOBERA RD	7.33	36	37	PG	PG	2	2	0
GP44B	TOBERA-MALAKUNA RD	2.64	37	92	PG	PG	2	2	0
GP44C	TOBERA-MALAKUNA RD	2.84	92	40	PG	PG	2	2	0
GP45A	ULAGUNAN RD	3.87	26	39	PG	PG	3	1	2
GP46A	TAKABUR RD	3.50	46	45	PG	PG	2	1	1
GP46B	TAKABUR RD	1.89	45	44	PG	PG	2	3	-1
GP47A	SONOMA RD	1.97	92	117	PG	PG	2	3	-1
GP47B	SONOMA RD	1.93	117	93	PG	PG	2	3	-1
GP48A	BITAKAPUK-WAIRIKI RD	3.42	60	132	PG	PG	1	3	-2
GP49A	KADAULUNG RD	0.97	63	62	PG	PG	2	3	-1
GP49B	SUNAM-KADAULUNG RD	0.83	62	70	PG	PG	2	3	-1
GP49C	SUNAM-KADAULUNG RD	10.58	70	98	PG	PG	3	3	0
GP50A	GAULIM RD	3.80	55	67	NG	PG	1	1	0
GP50B	GAULIM RD	8.69	67	73	NG	PG	1	1	0
GP50C	GAULIM RD	3.76	73	71	NG	PG	2	2	0
GP51A	GAULIM-BITAKAPUK RD	8.71	71	64	PG	PG	2	2	0
GP51B	GAULIM-BITAKAPUK RD	6.85	64	60	PG	PG	1	2	-1
GP51C	GAULIM-BITAKAPUK RD	1.36	60	113	PG	PG	1	3	-2
GP51D	GAULIM-BITAKAPUK RD	0.42	60	113	PG	PG	1	3	-2
GP52A	TAMANAIRIK RD	0.92	113	66	PG	PG	2	3	-1
GP52B	TAMANAIRIK RD	8.40	66	65	PG	PG	2	3	-1
GP53	RABAGI-RAPITOK RD	10.92	67	58	PG	PG	2	2	0
GP54A	CIS KEREVAT RD	3.96	76	74	NG	NG	1	3	-2
GP54B	CIS KEREVAT RD	3.60	74	72	NG	NG	1	3	-2
GP55	CIS TAULIL RD	4.31	73	72	PG	PG	2	3	-1
GP56A	KEREVAT-VUDAL RD	4.15	76	75	PG	NG	1	1	0
GP56B	KEREVAT -VUDAL RD	7.51	75	103	PG	NG	1	2	-1
GP57	CIS VUDAL RD	7.32	74	75	PG	PG	2	3	-1
GP58	LASSUL RD	52.39	103	114	PG	PG	2	3	-1
GP59	MALASAET RD	13.10	103	106	PG	PG	2	2	0
GP60	RAUNSEPNA RD	18.12	106	107	PG	PG	2	3	-1
GP61	WARANGOI-SIGUTE RD	17.82	41	94	PG	PG	2	1	1
GP62	SIGUTE-MERAI RD	56.67	95	97	PG	PG	2	1	1
GP62	SIGUTE-MERAI RD	2.34	94	95	PG	PG	2	1	1
GP63	SANBAM RD	16.62	95	96	PG	PG	2	3	-1
GP65	KAINAGUNAN-ILUGI RD	9.96	71	70	PG	PG	9	3	6
GP67B	VUNAKAUR RD	3.23	139	65	PG	PG	4	3	1
GP67C	VUNAKAUR RD	0.72	65	64	PG	PG	4	3	1
GP71A	LUMLUVUR RD	3.32	25	133	LG	PG	2	2	0
GP72A	RANIOLO RD	2.93	27	39	LG	PG	4	2	2
GP73	ARABAM RD	6.58	99	100	PG	PG	2	2	0
GP74	BUFFALO STN RD	1.51	42	43	PG	PG	2	3	-1
GP75	RIEIT RD	6.38	99	101	PG	PG	3	2	1
GP77A	VUDAL STLMNT RD	5.07	75	131	PG	PG	2	3	-1
GP78A	TAKUBAR-TOBERA RD	2.09	115	138	PG	PG	3	3	0
GP79	CLIFTON PLNTN RD	3.96	117	118	PG	PG	2	3	-1
GP80	TANAKA-TAPIPIPI RD	2.93	119	120	PG	PG	1	2	-1

Appendix 13. ENBPA road budgets 2004-2008

East New Britain
Provincial Budget - items related to road infrastructure
Year 2004

ITEM	FUND/PROGRAM/GRANT	CAT	BUDGET (K)
Road Transport Operation - Gazelle District	Road Transport Operation Grant	288	250,000
Road Transport Operation - Rabaul District	Road Transport Operation Grant	288	102,000
Road Transport Operation - Kokopo District	Road Transport Operation Grant	288	180,000
Road Transport Operation - Pomio District	Road Transport Operation Grant	288	270,000
Maintenance of Provincial Roads	Rotine Infrastructure maintenance	716	800,000
Upgrading Vunapalading-Raunsepna	MAJOR INFRASTRUCTURE UPGRADING	716	220,000
Upgrading Napapar-Tavilo	MAJOR INFRASTRUCTURE UPGRADING	716	100,000
Upgrading Malabunga-Gaulim	MAJOR INFRASTRUCTURE UPGRADING	716	200,000
Upgrading & sheeting Ravat-Kunakunai	MAJOR INFRASTRUCTURE UPGRADING	716	300,000
Upgrading & sealing JT Tyres-Lumluvur	MAJOR INFRASTRUCTURE UPGRADING	716	200,000
Upgrading South coast highway Sikut-Merai	MAJOR INFRASTRUCTURE UPGRADING	716	150,000
Upgrading & sealing Vunadidir-Nangananga RMRP	Road Maint & Rehab Proj (WB co-funded)	716	243,000
Upgrading & sealing Vunapalading-Lassul RMRP	Road Maint & Rehab Proj (WB co-funded)	716	243,000
Bridge replacement Turagunan RMRP	Road Maint & Rehab Proj (WB co-funded)	716	125,000
Reconstruction & sealing Vunapope-Bailu RMRP	Road Maint & Rehab Proj (WB co-funded)	716	132,000
Deck replacement & steel painting Mambur Bridge RMRP	Road Maint & Rehab Proj (WB co-funded)	716	18,000
Deck replacement & steel painting G/ford bridge RMRP	Road Maint & Rehab Proj (WB co-funded)	716	18,000
Deck replacement & steel painting Ilugi Bridge RMRP	Road Maint & Rehab Proj (WB co-funded)	716	18,000
Bridge replacement Sigute RMRP	Road Maint & Rehab Proj (WB co-funded)	716	90,000
Upgrading/resealing 3.0km Vunapalading-Utmei	Major infrastructure upgrading services	716	350,000
Upgrading/resealing 3.0km Ralubang-Ganai	Major infrastructure upgrading services	716	350,000
Resealing 4.0km NCR road	Major infrastructure upgrading services	716	200,000
Resealing 4.0km Malapau road	Major infrastructure upgrading services	716	200,000
Resealing 9km Baliora road	Major infrastructure upgrading services	716	200,000
Takup Rabata/Palumangas Bridge Maint. RMRP	Major infrastructure upgrading services	716	180,000
Mandress Causeway upgrading	Major infrastructure upgrading services	716	60,000
Mambaur Bridge replacement	Major infrastructure upgrading services	716	200,000
Gazelle Dist: Road Maintenance	District development consolidation	716	140,000
Gazelle Dist: Road upgrading Toma-Viviran-Wairiki	District development consolidation	716	100,000
Gazelle Dist: Road upgrading Vunapalading resettlmnt	District development consolidation	716	50,000
Rabaul Dist: Road upgrading, resettlement roads	District development consolidation	716	184,400
Rabaul Dist: Road upgrading, Namanula-Baai	District development consolidation	716	100,000
Kokopo Dist: Bridge upgrading, Rainau	District development consolidation	716	150,000
Pomio Dist: Road upgrading, Pomio-Gonaile-Nutuve rd	District development consolidation	716	100,000
Pomio Dist: Road upgrading, Uvol Ring Road	District development consolidation	716	150,000
TOTAL ROADS BUDGET 2004			6,373,400

ENB 2004 Total expenditure estimate	K78,640,600
Roads budget as a percentage of total provincial expenditure estimate	8.10%

East New Britain
Provincial Budget - items related to road infrastructure
Year 2005

ITEM	FUND/PROGRAM/GRANT	CAT	BUDGET (K)
Gazelle District Road Transport Maintenance	District Infrastructure Dev Maintenance		0
Rabaul District Road Transport Maintenance	District Infrastructure Dev Maintenance		200,000
Kokopo District Road Transport Maintenance	District Infrastructure Dev Maintenance		200,000
Pomio District Road Transport Maintenance	District Infrastructure Dev Maintenance		270,000
Roads and Bridges maintenance	Provincial Infrastructure Maintenance		960,000
Gazelle Dist - Vunapalading-Utmei Rd upgrade/seal	Major District Infrastr Upgrading Services		350,000
Gazelle Dist - Malaseat-Raunsepna road maintenance	Major District Infrastr Upgrading Services		200,000
Rabaul District - District Feeder Roads upgrading	Major District Infrastr Upgrading Services		100,000
Rabaul District - resettlement roads resealing	Major District Infrastr Upgrading Services		100,000
Kokopo District - Ralubang-Ganai Rd upgrade/seal	Major District Infrastr Upgrading Services		380,000
Kokopo District - Rainau Bridge Construction	Major District Infrastr Upgrading Services		250,000
Pomio District - South Coast Rd maintenance	Major District Infrastr Upgrading Services		200,000
Provincial sealed roads grasscutting	Major Infrastr Dev Consolidation (RMRP)		40,500
Kuradui-Navunaram Rd	Major Infrastr Dev Consolidation (RMRP)		200,000
Malapau - Tomavatur Rd	Major Infrastr Dev Consolidation (RMRP)		134,300
Baliora - Tokarongan Rd	Major Infrastr Dev Consolidation (RMRP)		134,300
Kabakaul - Ralubang Rd	Major Infrastr Dev Consolidation (RMRP)		200,000

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Vunapope - Bailu Rd	Major Infrastr Dev Consolidation (RMRP)	200,000
West Coast Rd	Major Infrastr Dev Consolidation (RMRP)	200,000
Rabaul Town roads	Major Infrastr Dev Consolidation (RMRP)	480,000
Vunadidir - Nangananga Rd	Major Infrastr Dev Consolidation (RMRP)	331,500
RMRP 10% GST	Major Infrastr Dev Consolidation (RMRP)	50,000
TOTAL ROADS BUDGET 2005		5,180,600
ENB 2005 Total expenditure estimate		K69,539,500
Roads budget as a percentage of total provincial expenditure estimate		7.45%

East New Britain
Provincial Budget - items related to road infrastructure
Year 2006

ITEM	FUND/PROGRAM/GRANT	CAT	BUDGET (K)
Road Transport Operation - Gazelle District	Road Transport Operation Grant	288	150,000
Road Transport Operation - Rabaul District	Road Transport Operation Grant	288	140,000
Road Transport Operation - Kokopo District	Road Transport Operation Grant	288	100,000
Road Transport Operation - Pomio District	Road Transport Operation Grant	288	100,000
Provincial Roads & Bridges Maintenance	Provincial Routine Maintenance	716	700,000
Utmei High School Road sealing (PPII)	PPII/IFA Support - Development Projects	716	300,000
Malasaet Raunsepna Road Upgrading (PPII)	PPII/IFA Support - Development Projects	716	200,000
South Coast Road Upgrading (PPII)	PPII/IFA Support - Development Projects	716	300,000
Bridge maintenance	Road Maintenance and Rehab Project	716	100,000
Ratunur-Gaulim Road major restoration works	Road Maintenance and Rehab Project	716	400,000
Ramale-Vunavutung Road major restoration works	Road Maintenance and Rehab Project	716	400,000
Gazelle Dist: Tavilo-Napapar Road upgrading	District Infrastr Upgrading Services	716	225,000
Gazelle Dist: LLG access road upgrading	District Infrastr Upgrading Services	716	110,000
Rabaul Dist: Resettlement roads & drainage	District Infrastr Upgrading Services	716	200,000
Kokopo Dist: Takubar Ring Road	District Infrastr Upgrading Services	716	200,000
Pomio District: no roads projects	District Infrastr Upgrading Services	716	-
TOTAL ROADS BUDGET 2006			3,625,000
ENB 2006 Total expenditure estimate			K88,253,300
Roads budget as a percentage of total provincial expenditure estimate			4.11%

East New Britain
Provincial Budget - items related to road infrastructure
Year 2007

ITEM	FUND/PROGRAM/GRANT	CAT	BUDGET (K)
Road Transport Operation - Gazelle District	Road Transport Operation Grant	288	100,000
Road Transport Operation - Rabaul District	Road Transport Operation Grant	288	100,000
Road Transport Operation - Kokopo District	Road Transport Operation Grant	288	100,000
Road Transport Operation - Pomio District	Road Transport Operation Grant	288	100,000
Provincial Roads & Bridges Maintenance	Provincial Routine Maintenance	716	100,000
Dirt & Sealed Roads Maintenance	Provincial Routine Maintenance	716	900,000
Kokopo Town Roads Maintenance	Provincial Routine Maintenance	716	100,000
Rabaul Town Roads Maintenance	Provincial Routine Maintenance	716	100,000
Utmei High School Road sealing	PPII/IFA Support - Development Projects	716	300,000
Malasaet-Raunsepna Road upgrading	PPII/IFA Support - Development Projects	716	200,000
South Coast Road upgrading	PPII/IFA Support - Development Projects	716	300,000
Baliora-Tokarongan Road	Road Maintenance and Rehabilitation Proj	716	300,000
Toma Junction-Ratunur Rd	Road Maintenance and Rehabilitation Project	716	300,000
Gazelle District - Vunavavar Rd upgrading	District Infrastructure Upgrading Services	716	60,000
Gazelle District - Kuradui Rd upgrading	District Infrastructure Upgrading Services	716	250,000
Gazelle District - Vunapalading Rd upgrading	District Infrastructure Upgrading Services	716	80,000
Rabaul District - Gelagela Rd resheeting	District Infrastructure Upgrading Services	716	70,000
Rabaul District - Nonga-Baai Feeder Red maintenance	District Infrastructure Upgrading Services	716	100,000
Kokopo District - Kabakaul-Ralubang Rd upgrading	District Infrastructure Upgrading Services	716	100,000
Kokopo District - Ulaveo-Malakuna Rd upgrading	District Infrastructure Upgrading Services	716	70,000
Kokopo District - Karavi Rd upgrading	District Infrastructure Upgrading Services	716	100,000
Kokopo District - Gelagela-Malakuna Rd upgrading	District Infrastructure Upgrading Services	716	100,000
Kokopo District - Ralubang-Ganai Rd upgrading	District Infrastructure Upgrading Services	716	250,000
Pomio District - Warangoi Bridge-Sikut Rd upgrading	District Infrastructure Upgrading Services	716	200,000
Pomio District - Uvol Ring Rd	District Infrastructure Upgrading Services	716	150,000
TOTAL ROADS BUDGET 2007			4,530,000
ENB 2007 Total expenditure estimate			K89,220,900
Roads budget as a percentage of total provincial expenditure estimate			5.08%

East New Britain
Provincial Budget - items related to road infrastructure
Year 2008

ITEM	FUND/PROGRAM/GRANT	CAT	BUDGET (K)
Road Transport Operation - Gazelle District	Road Transport Operation Grant	288	182,800
Road Transport Operation - Rabaul District	Road Transport Operation Grant	288	170,600
Road Transport Operation - Kokopo District	Road Transport Operation Grant	288	208,700
Road Transport Operation - Pomio District	Road Transport Operation Grant	288	146,200
Takubar Ring Road rehabilitation	Provincial Dev Improvement Prog	288	500,000
Karavi Road upgrading	Provincial Dev Improvement Prog	288	250,000
Palmalmal-Mu Road bridge upgrading	Provincial Dev Improvement Prog	288	150,000
Provincial Roads & Bridges Maintenance	Provincial Routine Maintenance	716	60,000
Dirt & Sealed Roads Maintenance	Provincial Routine Maintenance	716	970,700
Kokopo Town Roads Maintenance	Provincial Routine Maintenance	716	30,000
Rabaul Town Roads Maintenance	Provincial Routine Maintenance	716	80,000
Gazelle District - Upgrading of 3 economic roads	District Infrastr Support (Projects)	716	100,000
Rabaul Dist - Vunakabi Resettlement road upgrading	District Infrastr Support (Projects)	716	200,000
Kokopo Dist - Tinganalom-Ranguna Roads & Drainage	District Infrastr Support (Projects)	716	150,000
Pomio District - (no roads related projects)	District Infrastr Support (Projects)	716	0
Baliora-Tokarongan Road	Road Maintenance and Rehab Project	716	250,000
South Coast Road	Road Maintenance and Rehab Project	716	500,000
Utmei High School Road sealing	PPII/IFA Support - Dev Projects	716	800,000
TOTAL ROADS BUDGET 2008			4,749,000

ENB 2008 total expenditure estimate	K83,318,300
Roads budget as a percentage of total provincial expenditure estimate	5.70%

Appendix 14. Predictive model of ENB environmental potential for sweet potato yield

This documentation accompanies the mapping done for Figure 28 in the Gazelle Roads assessment report. It sets out the principle methods used to derive the map, which was constructed especially for this report. The map is the result of predictive modelling of growth (yield) of sweet potato in East New Britain (ENB), based on natural-environment growth factors.

Mapping was based on work by the Papua New Guinea Resource Potential Assessment (PNGRPA) project run in the Department of Human Geography, RSPAS, Australian National University around 1999-2001. The PNGRPA model is primarily concerned with setting seven parameters known as Relative Degrees of Limitation (RDOL) which summed together provide a score which predicts agricultural potential. The mapping units are the PNGRIS Resource Management Units (RMUs). The RDOLs behave like 'demerit points', where the higher the RDOL value, the worse that the yield is predicted to be. The PNGRPA project presented its results in Hanson et. al. 2001*a* (Papua New Guinea Rural Development Handbook) and discussed its methodology in Hanson et. al. 2001*b* (ACIAR Technical Report 50).

PNGRPA was based on the Papua New Guinea Resource Information System dating from the 1980s (Bellamy et. al. 1995), which itself was based on a series of detailed CSIRO studies undertaken from the 1950s to the 1970s. PNGRPA also incorporated some computer analysis of rainfall and seasonality done at the ANU in the 1990s and AGSO satellite cloud data analysis. PNGRPA was the latest in a pedigree of accumulated, scientifically-derived information. Each iteration has added to and refined its predecessor's stock of knowledge.

The original mapping of 'agricultural potential' in the PNG Rural Development Handbook was based on sweet potato potential. The mapped surfaces are discontinuous because the mapping was based on a composite of PNGRIS RMU regions and MASP agricultural systems regions. This had a significant limitation in that large areas are not mapped. Indeed the only areas mapped are those which the 1980 census showed were occupied. New areas where people have since moved into, or areas which might be considered for new settlement, are not shown. That limitation was the main reason for the present re-analysis; to predict the potential of all areas of East New Britain regardless of present occupation status.

Having embarked on the reanalysis and upon retrieving the original data files, it was discovered that a simple remapping would produce unreliable results and much more consideration should be put into how the model had originally been built. This eventually resulted in substantial revision and reassembly of the model. For the reanalysis, a script was written in MapBasic for MapInfo to easily allow changes to the various parameters and facilitate repeated trial-and-error runs. This was named RPA_macro.mb, written by Ian Scales and last revised for this study in August 2009. It operates upon a MapInfo table named ENB_RDOL. During the reanalysis of the PNGRIS/PNGRPA data, discussion was held with Mike Bourke, the agronomist advising the original PNGRPA analysis.

Limitations of the PNGRPA methodology and data

Hanson et. al. (2001*b*) did not fully describe the all-important relationships used to translate original PNGRIS or other-sourced data values into RDOL values. The legacy files from the project were disorganised and did not include any further documentation. To gain a more complete understanding, the relationship between the various inputs and the RDOL outputs was plotted graphically in each case. This allowed better assessment of the assumptions that had been made by PNGRPA. A number of points were noted:

- RDOLs were coded as integer values, although this involved significant rounding of numbers, i.e. unnecessary introduced error. It was decided in the present analysis to record RDOL values to 2 decimal places to help prevent cumulative rounding errors.
- PNGRPA made a lot of use of stepwise threshold values, although the natural processes

involved are not considered as displaying this kind of quantum criticality. Where possible the present analysis has replaced the stepwise relationships with straight-line relationships or second or third order polynomials (parabolic curves) as lines of best fit through either the original 'steps', or modified following advice from Mike Bourke.

- PNGRPA did not explicitly draw on published graphical relationships between sweet potato yield and the seven RDOL variables. In many cases this is because the information is not available or is ambiguous (Mike Bourke pers. comm. 2009). That these relationships are not quantitatively understood remains a strong limitation of the PNGRPA modelling.
- Once RDOL values are arrived at, there is no certain way to weight each factor relative to each other. For example, how much importance should be given to rainfall as against soil fertility? The original PNGRPA made no mention of the weighting problem, and did not account for it. One reason PNGRPA used threshold parameters in the original RDOL assignments was possibly to adjust more easily the parameters to get a fit between the model and the field data. It is better to separate the problem of defining each relationship from the problem of their interdependence: translate first, then weight later. As there are seven RDOL factors, all continuous variables, the permutations are infinite. Even trial and error matching of the model output to real field-work known conditions is practically impossible to refine. The weighting then has a significant element of subjective judgement involved, and this means that PNGRPA can only be a helpful learning tool for experienced agricultural scientists, rather than a definitive model of reality.
- Due to uncertainties in the original data, spatial resolution of the results should be considered as lower than the original units of spatial analysis. That is, the results cannot be used even at the RMU level but should be regarded as a fuzzy approximation spanning a number of RMUs in the area of interest.
- On using the reconstructed PNGRPA model presented here, it was found that small changes, particularly to the weightings, could quite dramatically alter the patterning of the colour-coded map produced by MapInfo. Many trials using different values were run before a map which broadly corresponded to known conditions was produced.
- Measurement of the probability of departure of the PNGRPA results from real conditions was not attempted by the original analysis or the present analysis. Potentially it could be achieved by comparison with the MASP results (q.v. Hobsbawn et. al. 1997 and Bourke et. al. 2002). In the meantime the results, either of the original analysis or the present analysis, have to be used with the caveat that 'results are probabilistic and approximate, and may differ significantly from the actual situation in any particular location'.

RDOL 1: Temperature

Temperature is not a critical factor for sweet potato production. Research has demonstrated that similar yields, albeit on different agricultural timeframes, are achieved in both lowlands and highlands settings (Mike Bourke, pers. comm. 2009).

PNGRPA calculated a temperature RDOL by converting the PNGRIS altitude coding, which due to a closely linear rate of change in the PNG environment, stood as proxy values of temperature. PNGRIS documentation (Bellamy et. al. 1995: 142) gave this conversion to temperature in terms of a 'maximum range' and 'minimum range' however this is practically of no consequence for the RDOL computation which outputs a single value for each PNGRIS altitude class.

The original PNGRPA RDOL relationship to PNGRIS code values is step-wise and with a sharp discontinuity at the 1800m height, where RDOL values are increased considerably. Discussion with Mike Bourke on the temperature requirements of sweet potato productivity suggests that temperature is not a major factor at all, except that at very high altitudes where it is too cold and there is a cut-off point. For current purposes of the ENB model I have drawn a fairly flat linear relationship that is biased toward more productivity in the lowlands, as per Hanson et. al's assumptions, but keeps this difference small, as per Mike Bourke's understanding. The

influence of temperature is further down-rated by the weighting which takes place at the end of the computations. The relationship between altitude and temperature is set as a straight line:

```
Set RDOL1_temp = .07 * Altitude + 0.5
```

RDOL 2: Rainfall

Rainfall is a very important variable for sweet potato yield. Yield falls off if there is either too little or too much rainfall. PNGRPA replaced the original PNGRIS annual average rainfall data with rainfall model data that was derived from the CRES ANUDEM hydrological model of PNG, calibrated with rainfall data records to 1976 (Mike Bourke pers. comm. 2009). It is sometimes called DEC data.

The original PNGRPA RDOL attribution is based on a series of step-wise threshold values. In discussion with Mike Bourke, the low rainfall penalty opted for by Hanson et. al. seems to be too severe; but the idea of a 'sweet spot' where rainfall is around 1800 to 2500 mm is retained, and increasingly worse crop yield as the rainfall increases after this. A polynomial was fitted through Hanson et. al.'s attribution relationship, bearing these revisions in mind. Two best-fit equations were computed for translation of the DEC data into RDOLs, one a second-order polynomial with a flatter curve and the other a third-order polynomial with a more pronounced 'sweet spot'. Both are shown here for reference, but the 3rd-order polynomial is the one that was used.[1]

A caveat on the use of the original rainfall data, all pre-1976, is that it may not reflect changes in average annual rainfall trends now underway in rainfall due to global warming.

```
Set RDOL2_rain = (-0.22 *(Dec_rain/1000)^3) + (2.54*(Dec_rain/1000)^2)
                 -(8.08 * Dec_rain/1000) + 8.54
```

RDOL 3: Seasonality

Rainfall seasonality (the length of the dry season) is a factor that particularly affects the Pomio district of ENB. I have made a new RDOL attribution graph, which provides a ramp instead of the sharp stepwise discontinuity of the original PNGRPA RDOL attribution. In this new attribution, seasonality index values less than 30 are given an RDOL of zero, and above 60 are given an RDOL of two. Between 30 and 60, a ramp is drawn. Neither Hanson et. al.'s assumptions, nor mine are supported by any quantitative study data, so has to be regarded as a guessed relationship. Note that in ENB, 'Season' ranges 13 to 60.

```
Where Season < 30
Set RDOL3_season = 0

Where Season >= 30 And Season <= 60
Set RDOL3_season = (Season * .0667)-2

Where Season >= 60
Set RDOL3_season = 2
```

RDOL 4: Cloudiness

Cloudiness data is used as a proxy for sunlight, a sensitive variable for sweet potato growth. The cloudiness data came from an AGSO remote-sensing satellite survey apparently in the early 1990s. The original data file has cloudiness in a range of 1 (very cloudy) to 5 (not cloudy) Hanson et. al. (2001*b*) used a threshold cut-off value to translate the AGSO data into either one of only two possible RDOL integer values, because of "the coarse nature of the AGSO cloud index and a reluctance to use the data beyond their inherent reliability." However introducing further error by this rounding is not a logical way to deal with data reliability issues. Rather, if the data is thought unreliable then the final weighting should downgrade the importance of the dataset overall.

The original PNGRPA method of converting the AGSO data (filename cloud96.shp) into the RMUs is unknown. Instead I have translated the cloud_index value in each RMU by calculating the

1 Not used: RDOL2_rain = (0.32*(Dec_rain/1000)^2) - (1.22*Dec_rain/1000) + 2.09

proportional average (a MapInfo command) of cloud96 polygon values within each RMU. The result of this translation as a proportional average is nicely graded, suggesting it is probably a valid translation method. However no information came with the Cloud96 data to say over what period the data was collected, so there is an unknown chance of data being non-typical in any area; this might be most of a problem around the coastal margins where high variation is apparent in the Cloud96 data, but a lot of the variation in the small Cloud96 coastal polygons has been averaged out across the much larger RMUs. (Note the value '0' in the original Cloud96 is confined to the map borders where there is no data).

The new relationship for translation of cloud_index values into RDOL values is assumed to be a simple linear relationship, ramping negatively to make high cloud-index values into low RDOL values and vice-versa.

```
Set RDOL4_cloud = (-1 * Cloud) + 5
```

RDOL 5: Inundation

PNGRIS contained RMU data for the occurrence of flooding, across a range of possible flooding types (e.g. tidal flooding, period brief flooding, etc., see Bellamy et. al. 1995:143). The PNGRPA RDOLs aggregated the original eight PNGRIS descriptive inundation types into four period-dependent values (no flooding, brief flooding, seasonal flooding, near-permanent flooding). However the PNGRPA RDOLs ignored the 'Iextent' field in the PNGRIS data, which indicated the proportion of the RMU facing the problem. The new RDOL values here multiply the 'inundation period' value by the 'extent' value. As the extent of flooding is usually less than 100% of the RMU, these changes downgrade the impact of wide-area inundation in most RMUs. The original PNGRIS inundation type data (code range 0 to 8) is kept in field 'Inund'. This is recoded into the four RDOL categories in field 'Iperiod'. 'Iextclass' recodes the original PNGRIS 'Iextent' codes according to table 3 of the PNGRIS manual (Bellamy et al. 1995:142), using the maximum value for each factor.

```
Where Inund =  0               ; Set Iperiod = 1
Where Inund =  1 or Inund = 2  ; Set Iperiod = 2
Where Inund =  3 or Inund = 4  ; Set Iperiod = 3
Where Inund >= 5               ; Set Iperiod = 4

Where Iextent = 0 ; Set Iextclass = 0
Where Iextent = 1 ; Set Iextclass = 20
Where Iextent = 2 ; Set Iextclass = 50
Where Iextent = 3 ; Set Iextclass = 80
Where Iextent = 4 ; Set Iextclass = 100

Set RDOL5_inund = Inund * Iextclass/100
```

RDOL 6: Slope

PNGRIS provides up to two slope classifications per RMU. The slope RDOL is computed from this PNGRIS data. However the method is inadequate because it is only approximately indicates the prevalence of gently sloping ground ideal for sweet potato. Further, we know from the PNG highlands that sweet potato can be grown on steep slopes although this is not common in lowland areas such as ENB. The data in each of the two slope fields is aggregated following the original PNGRIS coding (see Bellamy et. al. (1995:100), and identically with the method used by Hanson et. al. (2001*b*):

```
Where Slope2 = 0
Set RDOL6_slope = Slope1

Where Slope2 > 0
Set RDOL6_slope = (Slope1 * 0.6) + (Slope2 * 0.4)
```

RDOL 7: Soil fertility

Soil fertility one of the most important yield factors. PNGRIS provides up to three soil type codes and corresponding extent codes for each RMU. In ENB, the only available data is that recorded by PNGRIS RMUs, but there is no good way to disaggregate the PNGRIS data within the RMU. For this reason the quality of data available is inadequate.

Hanson et.al (2001*b*:17) defined soil fertility by classifying the original PNGRIS 'soilcode' 3-digit codes into a 1-to-4 index of fertility (or productivity: the two terms are taken to mean the same thing). This ranges from '1', very high fertility to '4', very low fertility. Value '0' is no soil record. Refer to Hanson et al. (2001*b*) and Bellamy et. al. (1995:143-4).

Following fertility assignment, the relative extent of each soil type is factored from PNGRIS extent coding. PNGRIS contains information corresponding to each soil type again on up to three soils in the RMU. The data in each of the three soil fields is aggregated following the original PNGRIS coding (see Bellamy et. al. (1995:100), and identically with the method used by Hanson et. al. (2001*b*). Basically, how the aggregate soil fertility score is calculated depends on how many soils are listed for the RMU. The three soil type fields were subscripted a, b, and c for each of PNGRIS soil1, soil2 and soil3 respectively.

```
Set RDOL7a = 0
Set RDOL7b = 0
Set RDOL7c = 0

Where  Soil1 = Any (131, 321, 322, 323, 324, 325, 542)
Set RDOL7a = 1  '(and repeat these steps for Soil2/RDOL7b and Soil3/RDOL7c)

Where  Soil1 = Any (132, 121, 122, 331, 333, 334, 411, 421, 532, 531, 533,
622, 623, 632)
Set RDOL7a = 2  '(repeat for 2/b & 3/c, as above)

Where  Soil1 = Any (141, 142, 143, 314, 315, 320, 332, 511, 512, 520, 610,
611, 612, 621, 631, 633, 732, 733)
Set RDOL7a = 3  '(repeat for 2/b & 3/c, as above)

Where  Soil1 = Any (110, 111, 112, 113, 114, 115, 211, 212, 220, 221, 222,
231, 232, 241, 311, 312, 313, 341, 351, 710, 711, 712, 713, 720, 721, 722,
730, 731, 811, 812, 821, 822)
Set RDOL7a = 4  '(repeat for 2/b & 3/c, as above)

Where RDOL7c > 0
Set RDOL7_soil = (RDOL7a * 0.4) + (RDOL7b * 0.3) + (RDOL7c * 0.3)

Where RDOL7c = 0 And RDOL7b > 0
Set RDOL7_soil = (RDOL7a * 0.6) + (RDOL7b * 0.4)

Where RDOL7b = 0
Set RDOL7_soil = (RDOL7a * 0.8)
```

Weighting the RDOLs by importance

Once each of the seven RDOL indexes have been coded, it remains to develop an aggregate score for yield potential. The RDOL values so far have arbitrary range values with respect to each other, or in other words the seven individual RDOL values have not yet been ranked in importance. They need to be weighted with respect to each other by assigning a multiplication factor to each. This can only be done by trial-and-error, inspecting the results each time for areas where actual agricultural production is known. For this calibration process, mapping of actual ENB crop combinations by agricultural system (MASP data) in Bourke et. al. (2002:68) was used. A check was also made using the 2000 census unit populations, overlaid as thematic population-variable size dots, to see if populations densities matched potential. A fair fit was eventually achieved.

RDOL	Weighting factor	Comments
RDOL1_temp	0.25	Temperature is not an important factor for SP yield
RDOL2_rain	1.50	Rain is a very important factor
RDOL3_season	1.00	Seasonality is important in areas where the effect is strong
RDOL4_cloud	1.00	Cloud affects light, which is an important growth factor
RDOL5_inund	1.00	Inundation inhibits SP yield but can be partly offset by drainage
RDOL6_slope	0.75	Slope is moderately important, but SP can still grow on slopes
RDOL7_soil	1.00	Soil is a very important factor but our data is coarse

The RDOL weights are user-adjustable, but the values shown are the final ones used in this study.

RDOL_sum: sweet potato yield potential

The final RDOL value, which is the measure for environmental potential for sweet potato yield, is computed by summing the seven individual final RDOL scores. Lower values mean greater yield potential.

```
Set RDOL_sum = RDOL1_temp + RDOL2_rain + RDOL3_season + RDOL4_cloud
               + RDOL5_inund + RDOL6_slope + RDOL7_soil
```

Thematic mapping of the result in Mapinfo is done using ‘equal ranges’.

Acronyms

ADB	Asian Development Bank
AIDAB	Australian International Development Assistance Bureau
AUD	Australian dollar
AusAID	Australian Agency for International Development
CPB	Cocoa Pod Borer
CU	census unit
ENB	East New Britain
ENBPA	East New Britain Provincial Administration
ENBRMP	East New Britain Road Maintenance Project
EU	European Union
GIS	geographic information system
GoPNG	Government of Papua New Guinea
GRA	Gazelle Restoration Authority
GRP	Gazelle Restoration Program
ITRP	Immediate Term Restoration Program
JICA	Japan International Cooperation Agency
K	Papua New Guinea kina
LLG	Local-level Government
LTRP	Long Term Restoration Program
M	million
MTRP	Medium Term Restoration Program
OLPLLG	Organic Law on Provincial and Local Level Government
PMV	public motor vehicle
PNG	Papua New Guinea
PNGRIS	PNG Resource Information System
PNGRPA	PNG Resource Potential Assessment
PPII	Provincial Performance Improvement Initiative
RDOL	relative degree of limitation
RMU	resource mapping unit
SNS	Sub-National Strategy
SRTM	Shuttle Radar Topography Mission
USD	United States dollar
UTM	Universal Transverse Mercator
WGS84	World Geodetic System 1984